THURSDAY, FEBRUARY 19, 1920.

THE ORGANISATION OF SCIENTIFIC WORK IN INDIA.

THE reorganisation and development of scientific work in India are now under consideration, and important and far-reaching decisions on these questions will shortly be made by the Secretary of State. It has already been decided, both by the Government of India and by the Secretary of State, that large sums of money must be found at the earliest possible moment for the purpose of fostering the development of the Indian Empire by means of scientific research. The principle of State aid on a generous scale has been accepted, but the important question of the best method of utilising this form of assistance in the future development of India remains to be settled. These matters were referred to by the Viceroy on January 30 last in his speech opening the present session of the Imperial Legislative Council at Delhi. It is evident from the report of Lord Chelmsford's remarks which appeared in the *Times* of February 6 that the Government of India is now considering large schemes of expansion in regard to the scientific activities of the State.

Two policies at present hold the field: (*a*) Centralisation under a proposed Imperial Department of Industries of the Government of India in which chemists, botanists, zoologists, and so on will be formed into distinct, water-tight, graded services, each under the control of a departmental head; and (*b*) decentralisation under which the scientific workers at the various universities and research institutes will be given as free a hand as possible.

The policy of centralisation and the creation of graded scientific services have been strongly advocated by the Indian Industrial Commission, which was presided over by Sir Thomas Holland, formerly Director of the Geological Survey of India. It is favoured by a number of administrators in India who consider that some measure of official control is necessary for all scientific investigators, and it has also received the support of several of the scientific witnesses examined by the Commission. The arguments advanced by Sir Thomas Holland and his supporters in favour of centralised scientific services are set out in detail in chap. ix. of the Report of the Indian Industrial Commission, published last year (H.M. Stationery Office; Cmd. 51). The nature of these arguments will be evident from a study of the principles and the rules which they suggest should be adopted for the formation and control of the new Chemical Service. It is proposed to proceed with the creation of this service as soon as the committee now dealing with this matter in India has submitted its report.

The Industrial Commission considers that for administrative purposes the chemists now employed by the State in India, and at present distributed among the cadres of various services, should be brought together into one service to be called the Indian Chemical Service, and should be under the control, so far as their scientific work is concerned, of a senior officer styled Chief Chemist to the Government of India. The remaining members of the service would be divided into three groups—agricultural, mineral, and organic chemists—each group being under the supervision of a Deputy Chief Chemist located at a suitable centre. The junior members of the groups would be lent to Local Governments and to various Government Departments for periods normally limited to five years; they would carry out the routine duties required, in some cases including teaching, and undertake certain forms of research with the approval of the head of the service. All the members of the Chemical Service would carry on their duties on the following lines: (i) Whenever it is possible to lay down for any officer a programme of research work, such programme would not be sanctioned without the consent of the head of the service; (ii) the head of the Chemical Service would have power to inspect the scientific work of any of his transferred officers and to report thereon to the local authority; (iii) the results of scientific investigations would be reviewed by the head of the service, and would not be published without his consent. Ordinarily, such results would be given their first formal publication in the official journal of the service.

These details will enable men of science in Great Britain to understand how it is proposed that most of the future scientific work in India should be conducted. As soon as the organisation of chemists is completed, the Industrial Commission suggests that the botanists, zoologists, and entomologists working in India should be formed into similar centralised services.

The present system under which research is conducted in India may be described shortly as one of decentralisation, the work being carried out at the various university colleges and at a number of independent research institutes under

the control of the Government of India, the Local Governments, the Indian States, and trusts, of which latter the Indian Institute of Science at Bangalore is the chief example. A large number of the most successful investigators working in the universities and at the various research institutes do not favour centralisation in separate scientific services, but consider that the present system should be developed and extended, and that in applied science the bond of union of the workers engaged should be the general subject investigated, such as agriculture or forestry, rather than the particular science involved. At present the investigators dealing with a many-sided subject like agriculture are collected at agricultural research institutes, and now belong to the agricultural department. A similar method of organisation obtains in forestry and at the centres of medical research like Calcutta and Bombay.

The present system has proved successful in practice, and the value of the work done in India in pure science, in tropical diseases, in agriculture, and in forestry has been widely recognised. Decentralisation, therefore, has been justified by success, and a very strong case will have to be made out before the workers at the existing institutes are re-grouped in centralised services under the control, as regards their scientific work, of the proposed Department of Industries of the Government of India.

Increased financial assistance on the part of the State would enable the present universities and research institutes to be developed and more workers secured. With such facilities, there should be the greatest possible freedom for the investigators carrying on original work. The general conditions under which the researches are conducted should be made as attractive as possible, and the policy to be adopted should be one which would secure the very best men available, and the provision of adequate means for their work. For original scientific investigators little or no official control is needed, and they should not be constantly called upon to furnish interim reports and programmes of work to an official chief, or to obtain his formal sanction before undertaking an investigation or publishing the results of their work. Such formalities waste valuable time, lead to constant friction, and are altogether foreign to the spirit which should reign in all centres of creative scientific research.

Briefly stated, the case to be decided is one between the advocates of a system of rigid centralisation and those who consider that in research work the man is everything, and that there can be no progress without freedom. Obviously, the conflict of opinion is a fundamental one, and much will depend on the wisdom and sympathies of the Secretary of State, with whom the final word lies, in deciding which policy is to prevail.

MODERN PHYSIOLOGY.

An Introduction to General Physiology: With Practical Exercises. By Prof. W. M. Bayliss. Pp. xv + 238. (London: Longmans, Green, and Co., 1919.) Price 7*s.* 6*d.* net.

"THE task of physiologists is to refer, as far as they can, all phenomena of life to the laws of physics and chemistry." With this definition Prof. Bayliss presents the student with those fundamental principles of these sciences which are of primary importance in the study of physiology. It is quite remarkable how the author can compress these principles into a small compass, and at the same time give such a clear picture, not only of these parts of physics and chemistry, but also of their applications in physiology. It is essentially an introduction to the author's "Principles of General Physiology," and reference is constantly made to this larger book. The student would often welcome, at these places, a rather longer description, for he will probably not possess the larger book at this period of his science course.

The book is so full of interest that if it were a little longer the beginner would not be overwhelmed, but would gather all the more fruit. The first chapter, entitled "Life and Energy," contains those parts of physics concerned in vital phenomena, written in illustration of certain phenomena easily observed with an amœba. Brownian movement is the visualisation of the moving molecules in a liquid. Protoplasm is a liquid containing matter both in solution and in suspension, and is surrounded by a cell membrane. Surface properties are those mainly concerned, but no grasp of their complexity is possible without a knowledge of energy and its laws. A considerable section is devoted to this subject. The change of energy at the surface of the cell is the cause of extrusion of the pseudopodium. The entry into and exit of matter from the cell is connected with osmosis and the permeability of membranes. This is most lucidly explained. Electrolytic dissociation and the colloidal state are included in the chapter.

"Food—Digestion and Respiration" are dealt with in the second chapter. A short cut is made through organic chemistry so as to give a con-

ception of sugar and amino-acids; it suffices at this stage if the student can differentiate the two classes of compounds, for the subject-matter is rather the origin and metabolism of carbon and nitrogen in Nature, and the supply of energy in the form of food. Food undergoes changes in the body as the result of enzyme action; the section on the nature of enzyme action is scarcely long enough, and reference must here be made to the "Principles." Respiration and oxidation are, in contrast, fully discussed. These two chapters are the chief ones in the book.

"Work—The Muscles and Stimulation—The Senses" are the subject-matter of chaps. iii. and iv. In the latter chapter there is a diagrammatic representation of the mechanism of the organ of Corti. Prof. Bayliss lays special stress upon a student getting a clear idea, even if it be erroneous, for it can be easily changed later, and it is far better than conflicting views which leave no impression. Chap. v. is a difficult one on "Adjustment—The Nervous System," and requires close attention to the text.

Chap. vi. is on "The Transport of Materials—The Vascular System." Here, again, we get an illuminating and fascinating description, while chap. vii., on "Growth and Reproduction," shows how the author himself has thought out his subject for explanation to the student.

Each chapter has a corresponding section on laboratory work, in which there is frequently some further explanation. The practical exercises illustrate the text, and are of varying difficulty. Many have been specially devised, while others are adaptations of existing experiments in physical chemistry or physiology. The value of experiments is very great, for science becomes a reality only in these circumstances. The average student may not appreciate the book, as it is not an "examination" manual. The time must soon come when the present system of practical examinations will be abandoned. Teachers should certify that their students have done a well-arranged course, and can do the experiments if given the proper opportunities.

Students of chemistry and physics will also find the book helpful in their work; many obscure points in their abstract information will be made clear by the descriptions here given. We agree with Prof. Bayliss that all beginners should have a course of *general* physiology, and we would fain see a return to the old system in which every science student worked through a course in physics, chemistry, and biology. The modern student has too restricted an outlook on one side or the other.

MENDELISM.

Mendelism. By Reginald Crundall Punnett. Fifth edition. Pp. xv+219+vii plates. (London: Macmillan and Co., Ltd., 1919.) Price 7*s.* 6*d.* net.

IN reviewing a new edition of a book so well known as Prof. Punnett's "Mendelism," it is unnecessary to notice more than the changes that have been made as compared with previous editions. The third edition (1911) was, in fact, a new book, and the fourth (1912) was substantially similar, with a certain amount of revision. Seven years have now passed, and although the war seriously interfered with genetic research in Europe, great progress in certain directions has been made in America, and it is to incorporate this new work that the chief changes in the present edition have been made. The first eight chapters are substantially unchanged, and comparatively little alteration has been made in the chapters on the economic aspect of genetics, on variation and evolution, and on man. To the chapter on intermediates there has been added an account of Nilsson-Ehle's theory of multiple factors as illustrated by his work on colour factors in wheat, by Davenport's work on mulattoes, and by Prof. Punnett's own work on the size-inheritance of fowls. Some special cases, such as that of doubleness in stocks, that were mentioned under various headings in previous editions are collected together into a special chapter on "Certain Complications." We note with regret that the hypothesis of "multiple allelomorphs," as illustrated by Nabours' experiments on grasshoppers and by certain characters in Drosophila—a hypothesis regarded by many as a preferable alternative to the presence-and-absence theory—is nowhere fully discussed.

The remaining changes and additions are almost entirely concerned directly or indirectly with the work of Prof. T. H. Morgan and his school on Drosophila—with the relations, that is to say, between Mendelian characters and sex, and with the theory that both Mendelian characters and sex are transmitted by chromosomes. Of the two chapters on sex, the first has been rearranged with some additions, but the revision has resulted (p. 92) in a reference to Abraxas as a case already described, while in fact it is not mentioned until p. 96. Incidentally, in this connection, it is an error to say that var. *lacticolor* has been recorded only in the south of Great Britain; the stock from which all or nearly all those now existing were derived came from Lancashire. We regret, also, that in this chapter the author has retained

the notation *Ff* for female and *ff* for male, in birds and moths, when the symbols *Mm* for female and *MM* for male are so much simpler of application.

The second of the two chapters on sex, and that on the chromosome theory of heredity, are almost entirely new, and give a compact and useful summary of the outstanding facts derived from Drosophila and the hypotheses founded upon them. Since nearly all this work has been done in America, where students of genetics use the word "sex-limited" in a sense quite different from that in which it is employed in England, a few words on the use of the words "sex-limited" and "sex-linked" on the two sides of the Atlantic might have been a help to readers unfamiliar with the subject.

Although we have noted a few points in which we think the book might have been improved, we do so only because any blemishes, however small, are regrettable in a book of such general excellence. We still regard it, as we did in its earlier editions, as one of the best introductory treatises on the modern study of genetics.

L. DONCASTER.

AERONAUTICS IN ITALY.

(1) *Meteorologia Aeronautica.* By Prof. Giuseppe Crestani. Pp. xv+315. (Milano: Ulrico Hoepli, 1919.) Price 8.50 lire.

(2) *Dizionario Internazionale di Aeronavigazione e Costruzioni Aeronautiche. Italiano, Francese, Inglese, Tedesco.* By Mario Mele Dander. Pp. vii+227. (Milano: Ulrico Hoepli, 1919.) Price 6.50 lire.

(3) *L'Aviazione. Aeroplani, Idrovolanti, Eliche.* By E. Garuffa. Seconda edizione. Pp. xxiii+955. (Milano: Ulrico Hoepli, 1919.) Price 20 lire.

(1) THE introduction and development of aerial navigation have brought into existence new applications of nearly every branch of experimental study, but perhaps none have been brought into greater prominence than meteorology. The safety and success of the pilot involve the most careful study and observation of every element, since barometric pressure, temperature, wind velocity, and cloud formation all affect the navigation of the machine. Hence Prof. Crestani's book will meet a real demand on the part of those who are training as pilots. There is, however, no essential difference between aeronautical and ordinary meteorology, except that more is required of the former. The first part deals with instruments and methods of observation. It describes the principal apparatus used in an observatory, and is in no way limited to the special equipments required for aircraft. Part ii. treats of the principal aerial phenomena, including atmospheric electricity. In part iii. the author deals with weather charts, pressure areas, and the circulation of the atmosphere, while part iv. is concerned with weather prediction. As an introduction to ordinary meteorology treated popularly, the book serves its purpose quite well. Still, as we have said above, something more is required by the pilot. We should like to see more about the means of making observations with the limited equipment that can be carried on aircraft, the modifications in weather prediction dependent on change of position and altitude during a flight, measurements and studies of solar radiation considered with reference to airships, and so forth. There is certainly room for additional treatment in regard to meteorological observations which are peculiar to aeronautical work. Meanwhile, the pilot must gain this knowledge by experience, and his one duty is to learn to observe and interpret phenomena instinctively.

(2) Lieut. Dander's pocket book provides for pilots and aeronautical engineers a dictionary similar in scope and plan to that supplied for gunnery by the "Trilingual Artillery Dictionary" reviewed in NATURE of November 27 last. It possesses, however, several features which were not contained in the subject of the previous review. Thus German is included, as well as English, French, and Italian, and, what is also extremely useful, anyone who is in doubt as to where to find a particular word will see at the end an index in which words in all four languages mixed are arranged in a single, strictly alphabetical sequence. This index is in rather small print, but as it is scarcely likely to be required up in the air this does not much matter. It renders the dictionary equally useful for persons of any of the nationalities which it covers, but English readers would prefer that the *genders* should have been indicated in Italian and French as well as in German. Airships as well as 'planes are considered, and materials of construction, including the names of timber trees, are fully dealt with, though the mathematical as distinct from the technical side is practically unrepresented. There are a few examples of weird English in the work, such as "three-plane," "helicoptery," "cok pit," "vestment" (for costume), not to omit the American "airplane." On pp. 48–49 the author evidently overlooks the possibility of wanting to paint anything red or black or even brown, but these colours are in other dictionaries.

(3) If Dr. Garuffa's book is to be regarded as representative of the present state of development of aeronautical engineering in Italy, English

readers have little to gain in the matter of substantial knowledge from their Italian competitors. The standard of the book is very much on a level with the swarm of weekly illustrated popular journals which may be seen in the waiting-room of an English aircraft factory or on the table of the library at Central House or of the Royal Aeronautical Society. As an introduction to practical aeronautics, the book will provide the Italian student with an insight into the mass of detailed information which is required by aircraft mechanics and pilots. The best portion is undoubtedly the descriptive account of the different types of aeroplane and their component parts, and as the machines selected for illustration are mainly of Continental make, the book may be of use to English readers for purposes of comparison. As regards the theoretical side, the treatment is very elementary, and imperfect formulæ and calculations are indeed abundant, but most of these are not much more than replicas of what one can find in our elementary school text-books on geometry and mechanics. The misfortune of this practice is that things look like new principles which are as old as the hills. But we in England cannot say much when one of our own weekly journals has devoted a glowing paragraph to the announcement that an American professor has discovered that two similarly electrified bodies can overcome gravity and repel each other.

In the sections dealing with pressures on component parts of aeroplanes, considerable prominence is given to Eiffel's diagrams of experimental results. The main difficulty in practice is that the pressures on the various elements of an aeroplane are not mutually independent, and for this reason we should have preferred a section dealing with the wind channel and its use, since this has become an indispensable adjunct to our aircraft factories.

The so-called " stability " which figures in a few sections does not in any way represent stability proper as studied in this country and tested experimentally at Teddington and Farnborough.

The sections dealing with navigation describe the usual instruments found on aeroplanes, and methods which do the ordinary, easy things, such as determining the position and velocity of an aeroplane when seen from the ground, which is very different from enabling a pilot to find his way in a fog or on a dark night. A lot of algebra is expended (p. 876) over a method of finding wind velocity by making an aeroplane fly in a quadrilateral path when ruler and compass would do the whole thing at once. The section on the seaplane contains the usual theory of the metacentre; the further developments required to take account of the effects of air resistance are briefly epitomised.

On the whole, the book fairly well meets the requirements of the average pilot, mechanic, or draughtsman who is in a position to leave more theoretical considerations in the hands of scientific experts (if he can find them).

In the *Atti dei Lincei*, xxviii., (1), 7, 8, Dr. Oreste Mattirolo considers the use of wood in the longitudinal bars of an aeroplane, with special reference to the effects of growth on the strength of the timber. During the war the timber used in the construction of aeroplanes was tested and examined by the author, and the existing methods were found to be inadequate. Dr. Mattirolo directs especial attention to the effect of climatic and seasonal conditions on the growth of the rings, and to the difficulty of locating weaknesses in the structure, and he cites two cases of accidents in which the wood was sent for his inspection and the defects were discovered too late. He recommends that now the demand for aeroplanes has lessened the longitudinal beams of the wings should no longer be made of wood. It is interesting to note that similar investigations in this country have been carried out in greater detail at Farnborough and elsewhere, though a number of problems still await solution in this as in other aeronautical investigations.

In another issue of the *Atti dei Lincei* (xxviii., 1, 2), Dr. Mario Tenani refers to the influence of the density of the air on the efficiency of aeroplanes, and quotes the ordinary laws of variation of density with pressure, temperature, and altitude in support of his plea regarding the importance of a subject which has received much attention in our country both in connection with airships and in experiments with variable propellers at Farnborough.

Meteorological difficulties should not be so serious in sunny Italy as in our land of fogs, though the Italian mountains may be set against the brighter climate. At the Pisa meeting of the Italian equivalent of our British Association, a paper on weather prediction was read by Prof. Filippo Eredia, at the end of which a resolution was passed advocating the joint action of the Ministries of Agriculture, Industry, and Commerce in co-ordination with the Air Department to promote researches in weather prediction with the view of furthering the development of commercial aviation.

Papers dealing with aeronautical subjects have, however, been conspicuous by their absence from the proceedings of learned societies in this and other countries, and the *Atti dei Lincei* has been no exception to the rule. If this is a result of the war we may welcome the three papers as an augury for a better state of affairs in the future.

G. H. BRYAN.

THE RE-MAPPING OF THE WORLD.

The "Times" Survey Atlas of the World. Prepared under the direction of Dr. J. G. Bartholomew. Part i. (London: Office of the *Times*, n.d.) Price 2*s*. 6*d*. net.

THE first part of this atlas contains four maps numbered respectively 21, 60, 79, and 95. The parts of the world represented are the southern section of Scotland, Farther India, Lower Egypt (from a little above Luxor), and Mexico and Central America (from Costa Rica inclusive). Three of the maps are, and, no doubt, the majority of those in the atlas will be, drawn on the layering principle, which has the advantages of conducing to clearness and indicating the broad distribution of high grounds and low grounds at a glance. This has been done with a skill worthy of the reputation which the map-making firm responsible for it has long held for work of this class.

The layering adopted is not on a uniform scale. In the same map successive contours represent different intervals of altitude. That, however, we have even in our own Ordnance Survey maps. But there are different scales of altitude on different maps otherwise somewhat similar. On the map of the southern section of Scotland the steps in altitude are by 250 ft. up to 1000 ft., then by 500 ft. to 2000 ft., and after that by 1000 ft. The only isobath is that of 10 fathoms. On two of the other maps the only isobath is that for 100 fathoms, but whereas in Mexico the isohypses represent 100, 500, 1000, 2000, 3000, 4000, 5000, and 6000 ft., and then 8000 and 10,000 ft., in that of Farther India they are at intervals of 500 ft. up to 2000 ft., and then mark altitudes of 3000 and 6000 ft. respectively. In the map of Egypt there are no isobaths (in the main map) or isohypses. Hachures are used to indicate the margins of the plateaux on the inset map showing the environs of Cairo on the scale of 1 : 150,000.

One noteworthy feature of the maps is that they are so mounted as to be suitable for loose-leaf binding, which will have the important advantages of allowing the replacement of a map without replacing the atlas and of enabling one to detach a single map at will for close examination and frequent reference. This feature might perhaps be utilised to remedy one of the defects of the maps, the smallness of the lettering where the names are too crowded. New maps might be drawn for those who would prefer them with fewer names in a larger letter, the missing names being entered in the index with their compass bearing and distance from places that are named on the map, say from railway stations, which are very easy to find.

We are promised an index of more than 200,000 names, but are not told how the index is to be prepared. Presumably latitude and longitude are to be given, as there is no provision on the border for reference by letter and number to the degree rectangles. But if latitude and longitude are to be the means of reference, or, indeed, in any case, we hope that the maps still to be issued will have the divisions of degrees marked on the border. That is not done in the four maps of the first part, with the result that in Scotland, for example, we have an interval for latitude of one degree measuring $6\frac{3}{4}$ in. without any subdivision showing minutes. On each map also the projection used should be named.

PHYSICS FOR MEDICAL STUDENTS.

(1) *A Manual of Physics.* By Dr. J. A. Crowther. Pp. xx + 537. (London: Henry Frowde and Hodder and Stoughton, 1919.) Price 16*s*. net.

(2) *Elements of Physics.* By Dr. R. A. Houstoun. Pp. viii + 221. (London: Longmans, Green, and Co., 1919.) Price 6*s*. net.

STUDENTS of medicine are apt to regard physics as a subject outside the range of their medical studies, a subject imposed upon them by certain grandmotherly examining authorities, to be forgotten as soon as the examination is over. Teachers of physics have to contend not only with this attitude of mind, but also with the fact that writers of physical text-books for the most part show but little evidence of sympathy with the medical applications of their subject. The ideal text-book for medical students would be written by a trained physicist who has specialised in medical work and is imbued with the spirit of research in physics as applied to medicine. Instead of studying the common steelyard, the medical student might then find the principle of the lever illustrated in the human frame, and instead of having to wade through a chapter on terrestrial magnetism, he might be given further information on the subject of meteorological physics and the conditions determining climate. He might even learn something as to electric oscillations applied in high-frequency treatment, or as to the use of a saccharimeter. Both the volumes under review claim to meet the needs of first-year medical students; but the ideal book on physics for such students has yet to be written.

(1) Dr. Crowther has given us an excellent manual of physics suitable for beginners who have no special profession in view. He has devoted considerable space to the subject of

mechanics, and experienced teachers will agree that "a thorough grounding in this most fundamental of all the sciences is the beginning of all wisdom in physical knowledge." The treatment of the various subjects follows conventional lines, a short chapter on the discharge of electricity through gases being the only one which deals specifically with the results of modern research. The style is lucid and interesting, and the explanation of physical principles exceptionally clear. It is to be regretted that the price of 16*s.* net should be so high as to make it impossible for many students to purchase the volume.

(2) A smaller treatise on the elements of physics has been written by Dr. Houstoun, who has attempted to cover the same ground in less than half the number of pages. The matter is consequently somewhat compressed and the style curt. The author has been successful in including a section on simple harmonic motion, which is so important in the study of vibrations; and another on the characteristic features of wave motion, in which the difference between a stationary and a progressive wave is well brought out. The work should be useful as giving a compact systematic treatment of the whole subject.

Both books are furnished with useful collections of questions and problems, and answers are provided for the numerical examples.

H. S. ALLEN.

OUR BOOKSHELF.

Harmsworth's Universal Encyclopedia. Edited by J. A. Hammerton. No. 1. Pp. xix + 128. (London: The Amalgamated Press, Ltd., 1920.) Price 1*s.* 3*d.*

THIS is, of course, a work of reference for the general reader, not the expert. The editor claims that it possesses the three necessary qualities, comprehensiveness, conciseness, and accuracy. All three are relative terms, and there is no absolute test by which his claim can be judged. But, since Mr. Hammerton is the acknowledged authority on What the Public Wants, the first claim may be conceded without further question. On the second the bare statement that A—*Afranius* occupies 128 closely printed but well-illustrated pages will enable the reader to judge for himself. On the third it is sufficient for NATURE to record that the scientific articles appear all to be as completely accurate as the space allotted to them will permit, and that one of the introductory articles, by Lord Moulton on "Science and the Future," is a model expression of the obvious; originality or profundity could not be expected.

We think the production is one of which the Amalgamated Press may well be proud.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relativity and the Displacement of Fraunhofer Lines.

IN view of the uncertainty in the interpretation of Einstein's equations in the matter of the displacement of solar spectrum lines, and of the hope which has been expressed that experimental spectroscopic evidence may be forthcoming which will settle the point at issue, it may be of interest to give a brief account of the present state of the problem from the experimental point of view. There are really three questions to which answers are required:—(1) Is there any means whereby the displacements of solar lines relative to those of terrestrial origin may be disentangled from such disturbing causes as pressure, varying arc conditions, density gradients, etc.? (2) If so, what do the outstanding displacements amount to? (3) To what extent are they due to gravitation and line-of-sight motion respectively?

Upon (1) it is to be remarked that, since both gravitation and motion displacements vary directly with the wave-length, they are indistinguishable spectroscopically; moreover, the possibility of separating their sum from those due to other causes, which in general displace spectrum lines (I have enumerated some ten possible causes in a recent communication to the Royal Astronomical Society), depends upon the reputed invariability of the wave-lengths of the cyanogen bands in different parts of the arc, under pressure, under varying current densities, etc. Practically all other lines are affected by one or more of these influences, and must be ruled out of account. Further laboratory experiments are necessary before the cyanogen bands can be regarded as suitable criteria, particularly in view of a recent statement from the Bonn Laboratory that they are unsymmetrical, which for well-founded reasons brings them seriously under suspicion for astrophysical purposes.

Even if we assume for the present that the cyanogen bands are satisfactory standards, (2) presents a further difficulty in that the Mount Wilson observers find displacements varying from 0 to about one-third of that predicted by Einstein; whereas Evershed and three Continental observers find a displacement of about one-half the required amount. It is possible that the discrepancy is due to the observations being made on different dates, since at Kodaikanal, on different occasions, measures made at the pole of the sun varied from one-half to the full predicted displacement. Simultaneous solar observations at Kodaikanal and Mount Wilson are, unfortunately, impossible, and it is a pity that the Australian Solar Observatory is not yet in existence to link up the two.

If Mr. Evershed and others prove correct, the problem still remains to interpret the half-displacement observed; obviously, this can be done only if by some independent evidence the motions of the vapours are known upon that portion of the solar surface towards which the spectroscope is directed. This involves a deeper knowledge of the currents in the solar atmosphere than we at present possess. There has been a disposition to regard displacements at the polar limb as free from motion effects, but it is inevitable that there will be surface currents, and these need not be of excessive violence in order to give displacements of the order of magnitude of those observed. The problem, if we accept Mr. Evershed's

data, resolves itself into choosing between (*a*) the absence of the Einstein effect, but the existence of currents of absorbing solar vapours moving away from the observer on the earth, and (*b*) the existence of the Einstein effect, together with solar currents of about the same magnitude as before, but in the opposite direction. The question thus involves an extensive knowledge of solar meteorology. There is, I fear, no immediate prospect of a rigorous solution of the problem of the displacement of the Fraunhofer lines with our present incomplete knowledge of the conditions necessary for the production of the cyanogen-band spectrum and with our present limited information regarding the circulation in the sun's atmosphere.

W. G. DUFFIELD.

University College, Reading, February 8.

Statistics of Valour and Service.

IN the Weekly Edition of the *Times* for November 28, 1919, the following statistics relating to decorations awarded for services in the field are detailed:—

	V.C.	D.S.O.	M.C.	D.C.M.	M.M.
Decoration	576	8,862	36,707	24,391	114,517
1st bar ...	2	695	2,932	468	5,719
2nd bar ...	—	70	167	9	180
3rd bar ...	—	6	4	—	1

An analysis of these figures, with a consideration of the results arising from such an examination, may be not without interest.

The figures may be reclassified as follows:—

Number of Individuals who have Won Decoration

	V.C.	D.S.O.	M.C.	D.C.M.	M.M.
With 0 bar ...	574	8,167	33,775	23,923	108,798
,, 1 bar ...	2	625	2,765	459	5,539
,, 2 bars ...	—	64	163	9	179
,, 3 bars ...	—	6	4	—	1

In making this reclassification I have assumed that all the decorations were won subsequent to July, 1914. There may be exceptions—as, for instance, in the case of Capt. Leahy, V.C.—but as the number of such cases must be small, their influence may be neglected.

In analysing these statistics I shall employ a type of method which I have applied with considerable success to medical problems, chiefly of an epidemiological nature (*Science Progress*, 1914; Proc. Lond. Math. Soc., 1914; and various papers in the *Indian Journal of Medical Research*). The argument as applied to the present case is as follows: Let us assume the presence at the Front of a community of individuals, initially undecorated, who were capable of earning the decoration in question provided that opportunity offered and recognition came. Let v_x be the number of individuals who at any moment were in the grade x—that is to say, who had received the decoration with $x-1$ bars. Let $\phi_x f(t)dt$ be the probability that an individual in grade x may during the time dt pass from the grade x to the grade $x+1$. For such a passage to occur, both opportunity must offer and recognition must come. The function ϕ_x allows for variations in the probability of further attainment being dependent on the degree of anterior attainment. The function $f(t)$ is unknown; it describes the ebb and flow of the conflict. Variations in the number of individuals in the grade x are composed of influxes and effluxes. The degree of the former depends upon the number of individuals who have already attained to the grade $x-1$, and the degree of the latter upon the number of those who are in the grade x itself. Thus

$$dv_x=(\phi_{x-1}v_{x-1}-\phi_x v_x)\,f(t)dt.$$

Let us assume as an approximation that $\phi_x=b+cx$. Let μ_1 denote the mean grade, and μ_2 and μ_3 the second and third moments about the mean respectively. By differentiating these values according to the time, and by making use of the above differential equation, we find

$$\mu_1=\frac{b}{c}(e^{c\theta}-1),\quad \mu_2=\frac{b}{c}e^{c\theta}(e^{c\theta}-1),\quad \mu_3=\frac{b}{c}e^{c\theta}(e^{c\theta}-1)(2e^{c\theta}-1),$$

where θ is written for $\int f(t)dt$; whence

$$c/b=(\mu_2-\mu_1)\div\mu_1^2,$$

and

$$\mu_1(\mu_2+\mu_3)=2\mu_2^2.$$

Solving the differential equation for successive values of x, and eliminating the unknown function θ, we have, if we remember that the participating population N was initially undecorated,

$$v_x=\mathrm{N}\frac{b}{c}\left(\frac{b}{c}+1\right)\ \ldots\ \left(\frac{b}{c}+x-1\right)\frac{\left(1-\frac{\mu_1}{\mu_2}\right)^x}{x!}\left(\frac{\mu_1}{\mu_2}\right)^{b/c}.$$

In the present instance, as in very many epidemiological problems, we are ignorant of the value of N, *i.e.* of the number of individuals in the participating population. On the assumption that our hypotheses are applicable, we can, however, calculate its value by making use of the above eliminant between the moments which results from our hypotheses, and by taking advantage of the fact that, in calculating the values of moments about any selected grade, information regarding the number of individuals in that grade is unnecessary, as in each case this number is multiplied by zero. In the present instance, as we are ignorant of the number of individuals in the zero grade (*i.e.* of the number of the undecorated), we employ moments about the origin. Let us denote the second and third of these by μ'_2 and μ'_3 respectively, then by introducing the values $n_1=\mathrm{N}\mu_1$, $n_2=\mathrm{N}\mu'_2$, $n_3=\mathrm{N}\mu'_3$, into the eliminant we find

$$\mathrm{N}=n_1^2(n_2-n_1)\div\{2n_2^2-n_1(n_2+n_3)\}.$$

The results of these calculations are indicated in the following table:—

Number of Individuals having the Decoration

	V.C.	D.S.O.	M.C.	D.C.M.	M.M.
With 0 bar ...	574	8,158	33,769	23,925	108,789
,, 1 bar ...	2	638	2,784	460	6,555
,, 2 bars ...	—	58	152	8	169
,, 3 bars ...	—	6	6	—	3

The correspondence between calculated and actual values is good, as was in some measure to be expected, since the number of grades in the statistics in no case exceeds four, whilst the number of constants at our disposal is three. We may, however, conclude that, for particular values of these constants, our assumptions are sufficient to account for the facts, and proceed to examine the significance which attaches to these values in the light of our assumptions. The final test of the adequacy of the assumptions must clearly depend upon the reasonableness of such inferences as may obtrude themselves.

These values are as follows:—

	N	c/b	$b\int f(t)dt$
V.C.	41,763	−0·5	0·014
D.S.O. ...	215,498	+2·96	0·042
M.C.	240,477	−0·005	0·166
D.C.M. ...	1,103,730	+0·735	0·023
M.M.	1,077,444	−0·096	0·113

In the values of N we have the values of the participating populations. To recapitulate: They denote the numbers of persons at the Front who were capable of earning the decoration in question if opportunity offered and recognition came. The standard of the

V.C. stands pre-eminent. Amongst the other four we find that the populations calculated for decorations awarded to non-commissioned ranks are to those calculated for decorations awarded to officers as approximately 5 to 1.

In the values of c/b we have a measure of the amount of increase in the probability of attainment as the individual passes from grade to grade. Thus if the likelihood of winning the decoration be unity, the likelihood of obtaining a first bar is $1+c/b$, and of obtaining a second $1+2c/b$. The value of c/b is positive if the likelihood increases with the grade, and negative if it decreases. The actual values may clearly be the resultant of both positive and negative influences. For the V.C. and the M.M. these values are frankly negative, that for the M.C. is nearly zero, and those for the D.S.O. and D.C.M. are frankly positive. This would suggest that the decorations fall into two classes which are earned under different conditions. Take, for example, the effect of risk. The value -0.5 for the V.C. would be accounted for if it could be shown that 50 per cent. of those who earned it died or were incapacitated in the winning. Thus the negative values of the first class of decoration can be accounted for by assuming a high degree of risk in the winning of them. Again, let us consider the questions of leadership and administrative ability. In these a positive value might indicate that although it was difficult for a soldier to get his opportunity in the first instance, once he had made his mark his opportunities for further distinguished service would be increased. The positive values found in the second class of decoration might thus be accounted for. Whether this explanation be the true one or not, it would appear that once the British soldier has got his foot on the ladder he makes good.

In the third column are tabulated values of $b\int f(t)dt$, calculated from $\log(N/v_0)$. If we assume that the ebb and flow of the conflict operate uniformly on the chance of winning each of these decorations, or that they do so within the respective classes, then the tabulated values may be taken as relative values of b, *i.e.* of the chance that an individual, potentially capable of winning the decoration, obtained it in the first instance. In this case also the factor is compounded of the chance that opportunity offers and the chance that recognition is received. Here again the V.C. stands pre-eminent. The low value for the D.C.M. is in agreement with what has been suggested in the preceding paragraph, viz. that it is relatively difficult for non-commissioned ranks to obtain a footing on the ladder. The high values for the M.C. and the M.M. would indicate that in this war of the trenches the opportunities for brave deeds were all too frequent. Taking the decorations separately, the results of this analysis are as follows:—

(1) The V.C. stands pre-eminent amongst the decorations, equally as regards the high standard which is required, the high degree of risk with which the winning is accompanied, and the difficulty of attainment even in the case of the individual who is admittedly of the required standard.

(2) The D.S.O. is an officers' decoration awarded both for deeds of valour, probably of a skilled kind, and for distinguished service of other sorts. The chance of opportunity offering and recognition being received may, in the first instance, be low, but, once obtained, there follows increasing opportunity.

(3) The M.C. is an officers' decoration in which probably the influences of both classes are combined, viz. risk and increasing opportunity. Opportunities of earning it were all too many.

(4) The D.C.M., for non-commissioned ranks, is of the same type as the D.S.O., though the chance of opportunity offering and recognition being received in the first instance is relatively less.

(5) The M.M., for non-commissioned ranks, belongs to the class of the V.C. It is characterised by the risk which the winning entails, and by the indication that the opportunities for the performance of brave deeds were many.

These, then, are the inferences which appear to me to emerge from the hypotheses which I have adopted. There may be others of which I am ignorant, but, such as they are, I venture to offer them as a tribute to the vast potentialities of the British Army, both for valour and for service—potentialities which even at the end of the great war remained to a large extent unexplored; and also as a tribute to the consistency and fairness which characterised the manner in which these decorations were awarded.

A. G. McKENDRICK,
Director.

Pasteur Institute of India, Kasauli,
January 1.

Sugar-beet Seed.

AT a recent meeting of the Sigma Xi Society of the University of Colorado Dr. W. W. Robbins, botanist to the Great Western Sugar Co., read a paper on beet-seed production. Dr. Robbins related that so early as 1909 Mr. Hans Mendelson, a German in the employ of the company, undertook to grow beet-seed in Montana. In those days all the seed was imported annually from Europe, principally from Germany, Austria-Hungary, and Russia. It was held by experts that the climate and other conditions would not permit the growing of the seed in America on a commercial scale. Mr. Mendelson thought otherwise, and stated that the time might come when it would be impossible to get European seed. So he continued his experiments on a small scale; and when the war came, and the supply of seed was actually cut off, he had developed his methods to such an extent that it was possible to save the industry. In 1916 the United States was able to produce 5,211,000 lb. of seed, and in 1917, 5,546,000 lb. Furthermore, experimental work had already determined the fact that American-grown seed gave a larger tonnage and a greater amount of sugar per acre than imported seed. From this time the policy of raising American seed will be continued.

I hope that Dr. Robbins will later on tell the whole story of the sugar-beet in relation to the war. The various events are part of the significant history of human progress. But just now it is worth while to note the value to the country of such men as Mr. Mendelson, and the importance of giving them a chance to test their ideas. The public is too apt to think that scientific progress comes only through great discoveries, or requires a Darwin, a Newton, or a Kelvin. It is difficult to exaggerate our debt to the great men of science, but it remains true that the current work of the world does not rest so much on sensational discoveries as on the multitudinous minor facts determined by a host of patient workers. Even Darwin could not have done his work without the aid of such. We shall never get on a proper basis until the scientific worker—no genius, but a normal man (or woman) doing his day's work—is established as a member of the community on a par with the tailor, the baker, or the policeman.

T. D. A. COCKERELL.

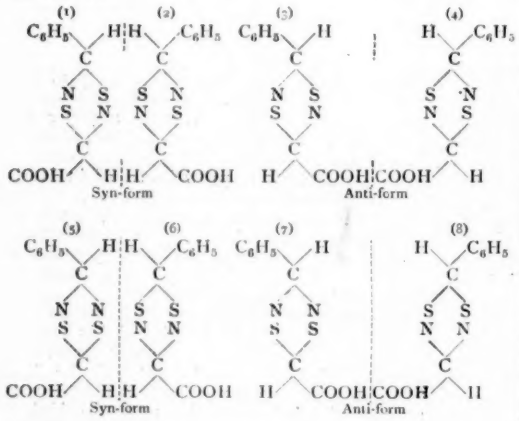
University of Colorado, Boulder, Colorado,
January 18.

An Electronic Theory of Isomerism.

THE application of the Bohr theory to organic chemistry suggests a possible explanation of the hitherto unexplained isomerism of certain organic

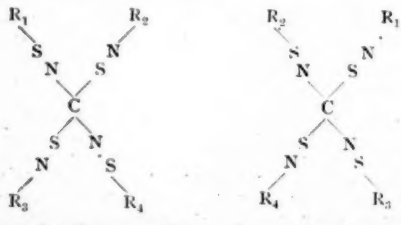
compounds. The electrons rotating in pairs around the four carbon valencies may possess either clockwise or anti-clockwise rotation with respect to the central carbon atom (Ramsay, Proc. Roy. Soc., xcii., A, p. 451, 1915–16). On the assumption that two of these pairs of electrons rotate in a clockwise and two in an anti-clockwise direction, it is possible to deduce that eight isomerides of cinnamic acid may exist. It has long been known that four isomerides of cinnamic acid exist, whereas only two are possible on the ordinary structural formulæ.

Erlenmeyer has recently shown (*Biochem. Zeitsch.*, 1919, xcvii., pp. 198–245) that ordinary cinnamic acid can be obtained in two optically active isomerides. If the clockwise rotation of the electron gives a north-seeking character to the valency, and the anti-clockwise rotation a south-seeking character, it is possible to represent eight isomeric cinnamic acids as follows:



The formulæ are grouped in pairs, and only two of these pairs are mirror images, (5) being the mirror image of (6), and (7) of (8). None of the isomerides 1 to 4 are superposable, as can be readily seen from the solid models. (A north-seeking valency will be the mirror image of a south-seeking valency.) The new type of optical activity is due not to the asymmetry of the radicles, but to an asymmetric arrangement of the pairs of rotating electrons.

It may be that the dextro- and lævo-rotatory forms of an organic compound are not structural isomerides, but owe their optical activity to this asymmetric arrangement of the electrons:



There is thus possible a large number of such isomerides in organic chemistry which are, however, stable only in very few types of organic compounds. The case of the cinnamic acids is not an isolated one, for it appears from the work of Erlenmeyer that benzaldehyde is capable of occurring in the dextro- and lævo-forms (*Biochem. Zeitsch.*, 1914, lxiv., pp. 382–92), and also, according to Marckwald, methyl-ethyl-malonic acid occurs in optically active forms.

This theory differentiates between two kinds of valency, according to whether the rotation of the electrons with respect to the valency is clockwise or anti-clockwise, and may explain the peculiar characteristics of the physical properties of the homologous series, where those compounds containing an even number of carbon atoms appear to belong to one series, and those with an uneven number to another series.

All the isomerides which are obtained on this theory, except the optical pairs, should possess different free energies according to the arrangement of the rotating electrons. W. E. GARNER.

University College, London, February 2.

The Sociological Society.

MAY I beg the hospitality of your columns for two announcements? First, the Sociological Society is moving from the London School of Economics and Political Science to a house of its own at 65 Belgrave Road, Westminster, S.W.1. The society hopes to get installed there by the beginning of March.

The second is that the society's new house affords more accommodation than the society itself can use, and we should be glad, therefore, to hear from congruent societies or organisations which might desire to rent one or more rooms. The present housing pressure is, we understand, putting not a few societies into a considerable difficulty as regards accommodation.

As to the situation, the new house of the Sociological Society is about five minutes' walk south-east from Victoria Station. It is just over a mile in a direct line from Charing Cross, and two 'bus routes (24 and 24A) cross Belgrave Road, within a couple of minutes' walk of the house. T. J. C. FRASER DAVIES,

February 16. Secretary.

Mirage Effects.

WHILE a patient at the Red Cross Hospital for Officers, Brighton, the phenomenon described by various correspondents was observed by me on numerous occasions last autumn. It was particularly noticeable on hot, sunny days along the Marine Parade, Kemptown. From a point opposite the Hotel Bristol, the road a quarter of a mile distant, *in either direction*, appeared as if flooded by a water-cart. Indeed, the illusion was so complete that the first time I witnessed it, being confined to a spinal chair, I instructed my attendant to make a detour.

ROBERT ROSS.

3 Sudeley Terrace, Brighton.

AN excellent place to observe mirage round our coasts is Morecambe Bay on a sunny afternoon when the tide is out and a fresh breeze is blowing in from the sea. Viewed from the low shore by Hest Bank, the Furness shore is clearly reflected in detail, even the steam of trains on the Furness Railway. Also, the bay towards Carnforth appears to be full of water where there is only dry sand.

Mirage effect on an asphalted pavement may be seen on the North Road between Newcastle-upon-Tyne and Gosforth when the sun is shining warmly and at the same time a cool wind from the north-east is blowing across it. The effect is observable to anyone walking up the road and approaching a level portion or slight depression. ALBERT TARN.

Barrow Hedges, Carshalton, February 15.

UNEXPLORED PAPUA.[1]

IN an interesting book on his experiences as a magistrate in the western division of Papua, Mr. Wilfred Beaver has given a vivid description of life in a practically unknown portion of that little-known land.

The western division is the largest in the territory, and has only partly been brought under Government control. It comprises the basins of the Fly River and the rivers east and west, from the Dutch boundary to the north-western portion of the Gulf of Papua. The people on the coast about Kiwai Island appear as a black, frizzy-haired race of medium height, narrow-headed, with the arched and prominent nose called Semitic. Inland skins are lighter, and noses shorter and straighter, while towards the east there are still other variations, but nowhere in this division is there any trace of the mixed people whom Seligman has described as Papuo-Melanesians.

After short sketches of Papua in general and of the western division and its history in particular, the author takes each river system or its hinterland in turn, as forming the most convenient means of describing the natives and the districts themselves.

In Kiwai the native houses are communal, varying from 250 ft. to 450 ft. in length. The whole roof is supported on the side posts, and, being carried forward over the end of the flooring, forms a verandah. The interior is divided into family compartments, each with its own fireplace. These compartments are open in the Fly River houses, and closed in those further east. All are now giving place to smaller houses, where married men sleep with their families.

Inland from the Fly River and at the western end of the division the bush people differ from those on the coast. The excessive use of *gamada* (*Piper methysticum*), the kava of Polynesia, has had to be prohibited by a Government regulation. In all this region the population is decadent, in the bush through pulmonary disease, on the coast through raids of tribes from the west.

The eastern part of the division on the coast and inland from the Papuan Gulf has scarcely yet been brought under control. Mr. Beaver gives an account of a pacificatory visit and the genesis of a Government station at Goaribari, where the Rev. James Chalmers and his party were killed in 1901. Cannibalism in this district was common, the stronger tribes gradually eating up the weaker. Yet these people are among the best physically in the possession, and, being quick, intelligent, and imitative, are now becoming employed in increasing numbers by white planters. The whole country being a region of swamps and morasses, the natives are naturally expert canoe-makers, and sago, both here and in the Fly basin, is the staple vegetable food, with bananas and yams when the soil is suitable.

Both at Kiwai and Mawata the natives are becoming "civilised," civilisation consisting in the wearing of European clothes, the use of European tools, and the laying out of the village in two streets of pile houses, each occupied by two families. "There is a flagstaff and a small court-house, a wooden church, and a trader's store." Amusing instances are given of the mingling of old and new ideas. Women make proposals, and brothers and sisters are exchanged in marriage, while the court for native affairs deals with affiliation orders and fines of thirty shillings for "philandering" with other men's wives.

FIG. 1.—Bamu River archer in full fighting dress. The gauntlet is worn on the left arm to protect it from the bowstring. The bamboo beheading knife is carried slung around the neck. The head-carrier is carried over the left shoulder. From "Unexplored New Guinea."

It is impossible to give an adequate view of these interesting chapters within the limits of a short notice. Mingled with descriptions of scenery and personal sketches of prominent natives are interesting accounts of native arts, fishing by means of the sucker fish, and the spearing of dugong from platforms on the reef. Dress or the lack of it, pigs and cassowaries, swamps and gardens, sorcerers' magic and charms, births, marriages, and deaths, are all dealt with in a most unconventional way. A chapter on property and inheritance and Dr. Landtman's account of the religious beliefs of the Kiwai people conclude the book.

The spirit in which Mr. Beaver wrote this most picturesque book is shown when he says: "There is a mystery about Papua that seems to enhance its

[1] "Unexplored New Guinea: A Record of the Travels, Adventures, and Experiences of a Resident Magistrate amongst the Head-hunting Savages and Cannibals of the Unexplored Interior of New Guinea." By Wilfred N. Beaver. With an Introduction by Dr. A. C Haddon. Pp 320. (London: Seeley, Service, and Co., Ltd., 1920.) Price 25s. net.

fascination. What that fascination is, and why there should be any at all, is hard to say. . . . Papua is a land of disappointment, a land where nothing happens as you anticipate, where the unexpected usually happens, and the impossible is achieved."

An introductory sketch by Dr. Haddon gives a short biography of the author, who was killed at Polygon Wood, in France, in September, 1917. His death deprived ethnology of a keen and intelligent observer, and the Papuan Government of a most zealous and successful magistrate, loved by his fellow-officers, and trusted by the natives, whom he understood and with whom he sympathised.

SIDNEY H. RAY.

FIG. 2.—Babiri man from near Dutch boundary. From 'Unexplored New Guinea."

ALPINE PLANTS FOR ROCK-GARDENS.[1]

"PROCLAMATIONS of purpose are often confessions of failure to achieve it," is the opening sentence of the Introduction of Mr. Farrer's book. His volume is "vast," and from the nature of the subject justly so. Mr. Farrer has not only given an account of the rock-garden plants which now figure in the nurserymen's catalogues, but has also unearthed from botanical treatises a large number which no doubt will some day come into cultivation, so that his book is of more than present-day value. In addition to this, he has been at great pains to discover the correct names of the plants he records, which has entailed considerable research into botanical literature, and for this valuable labour he is deserving of high praise. He also gives some useful information as to rock-garden construction, and throughout the volumes there are good practical instructions as to the cultivation of the various plants.

But Mr. Farrer has unfortunately failed to sink either his own individuality or idiosyncrasies in the volumes before us, so that instead of presenting us with a lucid and useful account of rock plants suitable for English gardens easy to be understood, he has expressed his own ideas and opinions with an exuberance of persiflage that is very irritating. In his Introduction of eighty-four pages and throughout the book the author seems far more interested in striving to commit extravagant excesses with the English language than in conveying useful information about Alpine plants, and in consequence many of the really valuable portions of the book tend to be overlooked. With regard to his descriptions of the plants, moreover, we cannot say that his work is very helpful. After his diatribes on the wearisome jargon of botanists one does not feel that the following description of *Dianthus arenarius* is either very intelligible or informing: "Related to *D. squarrosus,* is much laxer in the habit with fewer flower stems. taller and frailer and larger, with very fringy whirligigs of white or pale pink." Nor is this seven-and-a-

[1] "The English Rock-Garden." By Reginald Farrer. Vol. i., pp. lxiv+504+52 plates; Vol. ii., pp. viii+524+50 plates. (London and Edinburgh: T. C. and E. C. Jack, Ltd., 1919.) Price 3*l.* 3*s.* net two vols.

half-line sentence on *Primula Winteri* particularly illuminating: "It is unfair to say that the name of *P. Winteri* is a base and unpardonable pun, yet true it is that in midwinter always seem to emerge the crowded new rosettes of powdered, rounded, toothed leaves on their firm footstalks, and in their heart an interminable cabbage of these glorious, wide, lavender-lilac flowers with their fringed lobes and noble outline, succeeding each other for many months, in a rivalry of beauty, against the grey and mealy beauty of the robust leaves, if only the weather will allow. There is no other fault than this—which perhaps is merely due to the plant's inexperience—to be brought against this unparalleled introduction. . . ." A barren superfluity of words indeed!

Many extracts from this riot of verbiage might be made, but only one or two can be given. Of "the moonlight radiance of *Roscoea cantlioeides*," Mr. Farrer remarks: "Its nearest match is in the lucent citrons of *Meconopsis integrifolia*, but here the tone is yet blander and more serene, shining with a solemn and unearthly radiance as the blossoms, like ghostly butterflies of light, hover pale and vivid upon the background of dark pine-branches."

Then, again, when he speaks of *Aster lichiangensis* as "a bonus of the gods," or of *Anemone alpina*, almost blasphemously, as "the Great King of Glory," or of a double form of this species as "windmill-whirling," one feels tempted to relegate the book to "the dust and silence of the upper shelf."

Yet despite these adverse criticisms, which perforce bulk largely in a notice of the book, it is a real compendium of sound information and learning, though unduly biased in certain respects. On the genus Primula, for instance, which occupies nearly 100 pages, and on Saxifrage and many other genera, Mr. Farrer speaks as an authority, and we welcome his useful marshalling of information. Why he should dismiss Rhododendron in half a page because he says it "asks for a book" we fail to see. He appears to forget both here and elsewhere that only certain species in a genus are rock or Alpine plants. In a few pages ample accounts could have been given of *Rhododendron intricatum*, *R. fastigiatum*, *R. hippophaeoides*, and the few other Alpine forms, whereas he alludes to *R. praecox*, *R. dauricum*, and *R. ciliatum*, which are certainly not "rock-garden" plants in the usually accepted sense.

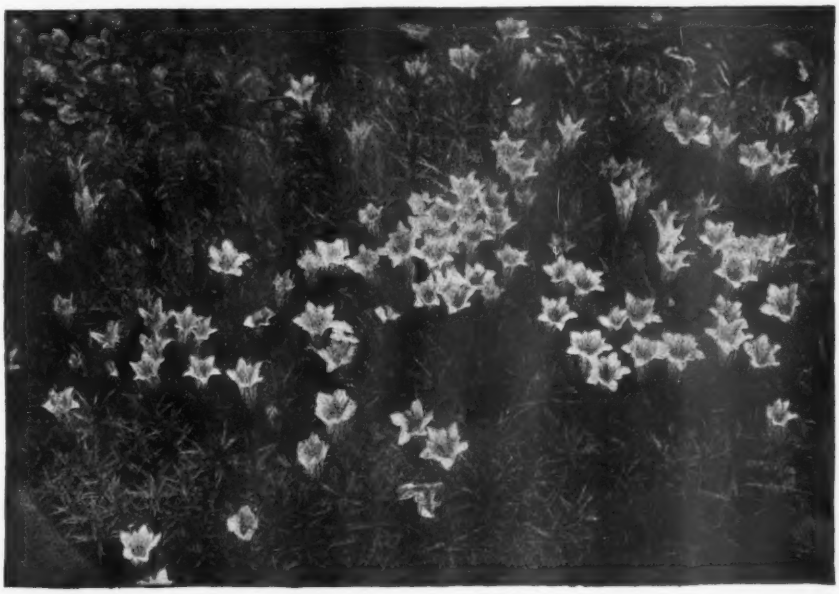


FIG. 1.—*Gentiana Farreri*. From "The English Rock-Garden."

The book is admirably illustrated with an excellent series of some 200 photographs. In reproducing the picture of *Gentiana Farreri*, a plant for the introduction of which gardeners will always hold Mr. Farrer's name in grateful remembrance, we cannot refrain from quoting his exuberant description: "*G. Farreri*, which sends out many flopping, slender shoots from the stock, clad in very narrow foliage, and ending each in a single huge, up-turned trumpet wide-mouthed, and of an indescribably fierce, luminous Cambridge blue within (with a clear white throat), while, without, long vandykes of periwinkle-purple alternate with swelling panels of nankeen, outlined in violet, and with a violet median line." *Non equidem invideo; miror magis!*

The publishers have also assisted to increase

the reader's irritation with the book, which, in spite of its too obvious faults, has many excellent qualities, by leaving the pages uncut and untrimmed—surely an unreasonable offence in a book of this character.

A NEW COPPER-REFINING INDUSTRY IN GREAT BRITAIN.

IN the last year of the eighteenth century Great Britain produced about 75 per cent. of the world's output of copper. The Cornish miners supplied most of the ore, and the Swansea smelters extracted and refined the metal. In the United States of America only a few tons were made. In 1913 the positions were reversed. Great Britain smelted and refined barely 6 per cent. of the world's production of this metal, and all but an insignificant fraction was derived from imported ores, matte, blister copper, and precipitate or cement copper. In the same year the United States of America furnished more than 55 per cent. of the world's total, and by far the greater part of this was obtained from home supplies of ore.

Whether in peace or war, copper is, and has long been, second in importance only to iron, not only in the various types of the commercial metal, but also in its numerous alloys. The enormously greater extent to which it is now used is not, however, generally realised. In 1800 the world's production did not exceed 10,000 tons, and that was probably the high-water mark of the annual production up to that time; in 1900 it had risen to about 500,000 tons, and in 1912 to about 1,000,000 tons. Thus, in little more than a hundred years, the production had increased a hundredfold.

During the war the whole question of the future of the copper-smelting and refining industries of this country was examined and considered by the Non-Ferrous Metal Trades Committee of the Board of Trade under the chairmanship of Sir Gerard Muntz. In due course the Committee reported, but the report has not been published. The announcement is now made in a recent issue of the *Times* that a syndicate has been formed to set up a large copper refinery in Devonshire, and has chosen a site near Newton Abbot, and that it is proposed to spend nearly 10,000,000*l*. on the scheme. The chairman of the syndicate is Sir Gerard Muntz. It is stated that Mr. H. J. Wilson, who originated the scheme, at first intended to harness and utilise the water-power of the Dartmoor plateau, but so much opposition was shown in some quarters that this proposal has been abandoned, at any rate for the time being. It has been decided to utilise a large deposit of lignite, of which it is estimated that more than 800,000,000 tons are available for the generation of the electric power required. At the site chosen there are tide-water facilities. By-products will be collected and marketed. The power generated will be mainly devoted to the electrolytic refining of copper, but it is considered that it will be so cheap as to enable current to be supplied in bulk to all the towns in South Devon, as well as to the industries which may be attracted to the neighbourhood.

The lignite deposits have only been used locally to a small extent. The *Times* states that a few months before the outbreak of war a party of Germans conducted a series of experiments and acquired a considerable tract with the evident intention of developing it on a large scale.

In the years immediately preceding the war the United States of America refined electrolytically more than 90 per cent. of the world's output of crude copper. Most of this production was absorbed by the electrical industry. Great Britain, accordingly, was obliged to obtain the bulk of this type of copper from America, and in 1913 imported about 100,000 tons. In view of the great importance of the home electrical industry, it will be obvious that the proposal to establish a large electrolytic refinery in a suitable locality possesses value which it is not easy to exaggerate. It should be pointed out, however, that the refinery will have to depend mainly upon imported blister copper for its raw material, since only a small amount of this metal is smelted in Great Britain at the present time. There are no longer any considerable home deposits of copper ore, and the few smelters who do exist have found it more and more difficult to obtain smelting materials. The United States of America, by virtue of the extent of its control of its own deposits and of those in Chile, is able largely to influence the price of copper, and the policy pursued by the works there is to attract smelting materials from other countries for treatment. The Americans can afford to pay high prices for imported ores, because the remainder of this raw material is produced at home at a price which is so low that a low average selling price for the whole serves to secure an adequate profit. In Great Britain only a few copper manufacturing firms and one or two companies owning mines abroad can afford to operate smelting works under these conditions. This consideration has no doubt been given its due weight by the syndicate, but it has not been made clear upon what sources they will rely for their blister copper.

In conclusion it must be stated that in this country a small amount of electrolytic refining is carried on, and that there are a large number of manufacturers who are engaged in the furnace-refining of blister, Bessemer, and other varieties of the crude metallic copper, and in producing the "tough" and "best selected" brands of the metal. The "tough" quality is used chiefly by the engineering and shipbuilding industries, and the "best selected" for the manufacture of alloys. In the production of this class of material the works in Great Britain are, and have long been, pre-eminent. If, therefore, the plans of the syndicate are successful in providing British manufacturers with sufficient supplies of electrolytically refined metal for their purpose, the production of this commodity in Great Britain will be placed on a much more satisfactory footing than it has been for many years.

H. C. H. CARPENTER.

THE "TIMES" AFRICAN FLIGHT.

DISCOVERY OF A NEW VOLCANIC FIELD.

NEWS has been received with great disappointment that, owing to the failure of the engine, Dr. Chalmers Mitchell's trans-African flight was checked on February 11, when a descent had to be made in the bush, and then the machine was taken to Jebelein for repairs. The South African machine, the *Silver Queen*, has been irreparably smashed by a forced descent at night at Korosko. The troubles of both machines may be due to their having been unduly forced, owing to the supplies of petrol in some southern stations being apparently adequate for one machine only. The flight was resumed on February 14, and a point twenty miles from Mongalla was reached at 4 p.m. on that date. On the following day the short flight was taken to Mongalla, where Dr. Chalmers Mitchell expected to be detained for three days. In his latest message, dated February 16, he says:—

> I consider the Cairo-Khartum part of the route satisfactory if relays of aeroplanes are available. The arranged landing-grounds are good and forced descents fairly practicable. The stage from Khartum to Mongalla is extremely dangerous, as the arranged aerodromes are difficult to locate and forced descents require luck and unusual skill. Bush fires destroy visibility, and render the smoke fires on the aerodromes useless as guides. The positions of the wireless station and the telegraph wires at Mongalla are extremely dangerous. The pilots, the mechanics, and the Vickers' "Vimy" machine are excellent. We hope that the worst of the trip is over, but must proceed slowly.

Dr. Chalmers Mitchell has thus successfully achieved more than one-third of the journey along Africa, and has shown how valuable aeroplane surveys may be by a discovery of first-class importance. After leaving Assuan, on approaching the section of the Nile flowing from south-west to north-east from Dosha to Korosko, he remarked many high hills with steep walls running north-east and south-west. These steep hill-fronts may indicate that both the section of the Nile above Korosko and the parallel section from Korti to Abu Hamed were determined by earth-movements, which have a wide influence in this part of Africa; for the section of the Nile flowing from Abu Hamed south-west to Korti is in line with a remarkable breach through the mountain rim of the Red Sea basin. The mountains which extend west of the Red Sea from behind Kosseir, southward past Berenice and Mersa Shab, end to the south-east in the group of Adal Qaqa (about 5925 ft.). The geology of this group is known by the monograph by Dr. J. Ball (1912), whose maps indicate the existence of faults of late Cretaceous or post-Cretaceous age, some of which trend north-west to south-east, and others from north-east to south-west. South-east of Adal Qaqa the highlands are resumed by the mountains which extend south from Gebel Elba, west of Cape Elba, through Gebel Shendil (6275 ft.) and Gebel Asotriba (7270 ft.). The Adal Qaqa and the south-eastern groups are separated by a deep depression formed by the plains of Nafab and by the broad valley of the Wadi Di-ib which discharges to the Red Sea. The divide between the Nafab and Wadi Di-ib is probably less than 2000 ft. above sea-level. The straight course of the 1000-metre contour line on the south-eastern side of the Adal Qaqa group, as shown on the 1:7,500,000 map of the Nile Basin by the Egyptian Survey (1906), occurs on the extension of the line of the Nile from Abu Hamed to Korti. On the continuation of this line across the Red Sea the irregularities in the front of the Arabian plateau between the coastlands of El-Gof and Medina may be due to the same tectonic cause.

The representation of the 1000-metre contour near Adal Qaqa may be untrustworthy, or its continuation on the line of the Nile from Abu Hamed to Korti may be only a coincidence. But the probability of a long north-east to south-west fracture is strengthened by the discovery by the *Times* Expedition of a group of extinct volcanoes in the Bayuda Desert, half-way between Merowe and Berber.

The discovery is quite new, since this volcanic field was unknown to so alert an observer as Mr. G. W. Grabham, the Government Geologist of the Sudan. Mr. Grabham has, however, been able to support Dr. Chalmers Mitchell's identification, as he had received some volcanic tuffs obtained by Sir Herbert Jackson about fifty miles distant from the craters seen by Dr. Chalmers Mitchell. There was apparently no evidence as to the age of these tuffs, or whether they came from modern volcanoes, but Dr. Chalmers Mitchell concludes from his observations that the eruptions were not later than the Kainozoic, and as he refers to the hills as craters they were probably formed late in that era. The great earth-movements along the Rift Valley are frequently associated with volcanic outbreaks, due to material compressed by the subsidence, being forced up the adjacent fractures. Dr. Chalmers Mitchell's discovery, therefore, suggests that one line of crustal fractures explains the bend of the Nile south-westward from Abu Hamed to Korti, the Nafab—Di-ib depression, and the Bayuda volcanic field.

Col. Lyons has shown that the course of the Nile from Berber to Korosko is comparatively young, and that above Berber, as at the Shabluka Gorge, it has re-excavated a new channel through the comparatively soft rocks which have filled up an older valley. It therefore seemed possible, from the information previously available, that the disturbances which have given the Nile its S-shaped course from Korosko to Khartum were due to earth-movements contemporary with the breach through the Red Sea rim near Berenice. This conclusion is strengthened by the discovery of the Bayuda volcanoes. The movements doubt-

less happened during the Kainozoic era, and Dr. Chalmers Mitchell's observations on the condition of the volcanic hills of the Bayuda will probably indicate a more precise date.

J. W. GREGORY.

THE NATIONAL RESEARCH COUNCIL OF THE UNITED STATES.

AN account has recently been published of the organisation established by the National Research Council of the United States for the carrying out of its work. Americans are proud of their organising ability, and it is very interesting to study the efforts of the men of science of America to develop their scheme of mobilising the whole strength of American science for the promotion of the national well-being and for the advance of science itself.

The National Research Council was established to deal with war problems. It was started by the men of science themselves; they recognised that although the Government had already strong scientific bureaux, there were many other workers who in the isolation of their own laboratories were almost unavailable, but eager for opportunity to help. This organisation is now being completed and put on a permanent basis. We are told that it differs from organisations for similar purposes in England, Canada, Australia, and Japan in that, while recognised by Government, it was not initiated or organised by Government, and is not supported by it. Its support is derived from funds contributed by private sources.

The machinery is somewhat elaborate. There are seven divisions devoted to special branches of science and technology. These divisions are physical science, engineering, chemistry and chemical technology, geology and geography, medical science, biology and agriculture, and anthropology and psychology. The members of each of these divisions include representatives of societies dealing with cognate subjects, other scientific workers, and representatives of firms. Attached to each division there are a very large number of committees to give attention to special problems. But in addition to this classification into seven divisions there are six "general relations" divisions—a Government division, a division for foreign relations, a division of States relations, a division of educational relations, a division of industrial relations, and a division of research information. The idea underlying these divisions may be seen from their constitution. For example, the educational division has a membership including representatives of all the principal university associations, the United States Bureau of Education, the Carnegie Foundation for the Advancement of Teaching, etc. The division for research information will, we are told, be a national centre of information concerning American research work and research workers, with all its information promptly available to institutions and individuals interested in knowing at any time what problems are under investigation in America and their status.

The National Research Council has permanent headquarters in Washington, with an executive staff of men of science giving their whole time to the work of their respective positions. Each of the divisions has a resident chairman and a small office staff in Washington.

It is not yet possible to say much as to the actual work of the new Council. From the list of subjects being studied by the numerous committees of the different divisions, it would appear that problems of wide national interest are receiving first attention. If we compare the American organisation with that of our own Research Department as shown in its annual reports, it would seem that in America the scientific worker is organised to a greater, and the industrial leader to a less, degree than in this country. There is nothing in the American scheme that quite coincides with the research associations for each large industry established by our Research Department. It is clear that both the American Department and our own will have much to learn by watching each other's development, and it is to be hoped that some degree of co-operation may be established in connection with problems of interest and importance to both nations.

The official organ of the National Research Council for the publication of accounts of research work and of committee and other reports will be the Proceedings of the National Academy of Sciences, but in addition the Council proposes to publish a Bulletin at irregular intervals. The first number of the Bulletin contains articles by Dr. G. E. Hale and other writers on different aspects of the national importance of scientific and industrial research. Dr. Hale gives an account of the origin of the Council and outlines its objects. He argues against the view that organised effort in science may hamper the individual investigator and hinder personal initiative. In his opinion, well-planned co-operation stimulates the individual and brings out his best and most original efforts. The Council will favour this type of co-operation, but is opposed to all attempts at a central control of research.

The Hon. Elihu Root writes on the need for organisation in research, and holds that science has been arranging, classifying, methodising, and simplifying everything except itself. One fears that the degree of organisation suggested by Mr. Root would almost amount to the control which Dr. Hale tells us the Council has no wish to attempt. Other articles dealing with the relation of research to industry are written by men of wide experience in large industrial concerns, and the Bulletin concludes with an account by Mr. Howe of the organisation of scientific and industrial research in the United States, the British Empire, France, Italy, Japan, and Belgium. An appendix contains a list of non-military researches undertaken by the Council covering a wide range of subjects, and especially numerous in the section of medical science.

THE SECONDARY SCHOOL CURRICULUM.[1]

THE Secondary School Examinations Council is an august body the members of which have for the most part more experience of university work and of administration than of secondary schools. The council was therefore well advised in selecting, for the investigation of the methods and standards of award of the seven approved first examinations, "panels" of experienced teachers. These have now made their reports, which are published for the information of all concerned. The conclusions reached are not so startling as to make the non-committal preface appear necessary in the eyes of a schoolmaster.

The mathematical investigators in particular have not exceeded their terms of reference, though a hint is thrown out that the present forms of compulsion may require revision. Thus "elementary mathematics should include arithmetic" seems a harmless proposition. To some examining bodies, however, "elementary mathematics" means algebra and geometry, and is not compulsory. Later there follows the sentence: "So long as mathematics is a compulsory subject for exemption purposes, the present standards for credit cannot well be raised, but they are in themselves unsatisfactory." It may be inferred that compulsory algebra is viewed with disfavour, a view which is shared by many examiners who have realised the appalling waste of time involved for half the boys and girls who try to learn algebra without attaining the power or even the need to apply it in the simplest way. Compulsory arithmetic is much more defensible, and it is a pity that the investigators have not maintained a clearer distinction between the two. In geometry it is recommended that the theorems on congruence of triangles, parallel lines, and angles round a point (*i.e.* Euc. i. 4, 8, 26; 27, 28, 29, 32; 13, 14, 15) should be omitted. We may infer that only the proofs of these theorems are indicated, and that the enunciations (*pace* Einstein) are to be assumed.

The science investigators have had to cover a wider field and to consider a greater variety of practice on the part of the different examining bodies. Thus in one examination a paper is set on "Elementary General Science," covering a very elementary treatment of heat, hydrostatics, chemistry, and botany, this paper having been recently introduced for the benefit of rural secondary schools. The "panel" is of opinion that further investigation of this general science work is particularly desirable. We may remark here that it would greatly help the movement if specimen copies of the paper referred to could be circulated among teachers and examining bodies. To quote the report: "The examination, like the syllabus in the schools up to the sixteen-year-old stage, should be suited to the capacity of the average pupil of sixteen, should cover a reasonably wide range, and should not encourage instead advanced work within a limited field. Further, it should not be confined to an abstract and academic treatment of the subject, but should require a knowledge of the applications of the sciences to everyday life. It must be remembered that at this age pupils obtain far more value from a concrete than from an abstract treatment of science, and this should be borne in mind both in drawing up a syllabus and in setting a paper. The investigators direct attention in this connection to the observations contained in paragraphs 47, 50, and 51 of the Report of the Government Committee on Science." Most teachers of science in schools will assent to this. The generation of science masters who began their science at the university is rapidly passing away. On them must partly rest the responsibility for the effort which has been made in the last thirty years to impart an appreciation of "scientific method" to boys at too early a stage. Now they are being followed by a generation of teachers who may have begun the systematic study of science at the age of twelve, and in some cases find themselves deficient in literary attainments. An undergraduate starting on geometrical optics is at a disadvantage if he has never handled lenses or prisms in such a way as to know their peculiarities; but if he has done this, and knows the meaning of the words used, he need not have been through a prolonged course of optical measurements, nor need he belong to the class of natural science students who come up "knowing how to measure every physical quantity, but with no ardent desire to measure any."

It may be remarked here that "general science" is no more than a branch of English, and that its teaching implies the demonstration to the various senses of the meaning of a number of English words. This has evidently been realised by the "panel" of geographers, whose remarks are worthy of quotation. They "are of opinion that geography should be a subject in Group I.; but they are of opinion that it should be a subject in Group III. also." Geography, in other words, is not only a branch of English, but also a branch of science. This is a bold saying, and it may possibly account for the cautious prefatory statement: "It must not be assumed that either the council or the board are at present committed to any or all of the suggestions." If geography is to belong to two groups, why not also general science? And why should not algebra find a place among the foreign languages? The insidious suggestion might lead to the collapse of all the walls of partition and to the survival of English as the one essential subject, as seen in a vision by Sir Arthur Quiller-Couch. For the investigators in English report thus: "They are of opinion that (in the interests of the language and of lucidity of expression) a reasonable standard of English should be required in all subjects of the examina-

[1] Secondary School Examinations Council. Reports of the Investigators Appointed to inquire into the Methods and Standards of Award in the Seven Approved First Examinations held in July, 1918. Group I., English, History, Geography; price 6*d*. Group II., Classics, Modern Languages; price 4*d*. Group III., Mathematics, Science; price 4*d*. (H.M. Stationery Office.

tion." Again: "No candidate should obtain a certificate who does not show a good command of English and the power of writing it intelligently." If to this were added the power of reading English intelligently, which implies a knowledge of the meaning of a number of words in common use under the headings of geography, history, and general science, and, finally, the power of doing simple arithmetic, is it not conceivable that a candidate possessing these three powers might be thought fit to continue his studies at any university of the realm?

NOTES.

BOTANISTS in Great Britain have been considering the practicability of holding an Imperial Botanical Congress in London at which botanists from the overseas Dominions might meet their colleagues at home for the discussion of matters of common interest. Many subjects are ripe for discussion, such as the methods of training botanists for service abroad, the relation between the pure science and its applications and between the botanist and the commercial men interested in industries in which botanical knowledge should play an important part, more helpful co-operation between the home and the overseas botanist, botanical surveys of overseas Dominions, and others. After careful consideration it has been decided that it would be inadvisable to hold such a congress during the present year.

M. LUCIEN POINCARÉ, Vice-Rector of the University of Paris, will be entertained at dinner by the Groupe Inter-Universitaire Franco-Britannique on Monday, February 23. The dinner is being organised in connection with the formal opening of the British Bureau of the Office National des Universités et Ecoles Françaises by M. Poincaré. The chair will be taken by M. Petit-Dutaillis, Director of the Office National. Amongst the members who have intimated their intention of being present are his Excellency the Belgian Ambassador, his Excellency the Greek Minister, the Lord Chancellor, the Earl of Reading, Viscount Burnham, the Right Hon. H. A. L. Fisher (President of the Board of Education), the American Consul-General, Mr. Austen Chamberlain, and the Lord Mayor and Lady Mayoress.

THE anniversary of Sir Francis Galton's birth, February 16, was celebrated by the Eugenics Education Society as usual this year. Prof. Arthur Keith delivered the Galton lecture, and this was preceded by a dinner at the Connaught Rooms. These annual gatherings have been held since 1914 in every year but one, when war conditions stood in the way. In his interesting lecture, which will be printed in full in the next issue of the *Eugenics Review*, Prof. Keith gave a sketch of Galton's life in so far as it affected his work, and a broad and general account of his investigations and theories. The main thought running through his address was that Galton's work had not been adequately appreciated during his life, and that his reputation would increase as time went on. In Galton's day anthropologists concentrated their attention on the individual man, whilst it was equally necessary to consider the distribution of men according to their qualities. Hence Galton's teachings made slow progress because they fell on unprepared ground, whereas in the future he would come to be recognised as one of the greatest men of science produced in England during the nineteenth century. Major Leonard Darwin was in the chair, and said that Galton always had practical aims in view and always had the courage of his opinions. If ever the *name* of eugenics came to be captured by cranks it would be because scientific men did not follow his example, and, through fear of contact with cranks, gave this important subject lukewarm support. The *science* of eugenics could never suffer in this way, because it was founded on indisputable truths. The proceedings terminated by a vote of thanks moved by Sir Robert Blair and seconded by the Dean of St. Paul's.

AT the National Conference of Manufacturers and Producers, held at Kingsway Hall on February 11, Sir Robert Hadfield, representing the Federation of British Industries, proposed a resolution appreciating the work of the Department of Scientific and Industrial Research, and strongly urging all manufacturers, either individually or collectively by trades, to organise and maintain research facilities. In the course of his remarks Sir Robert Hadfield affirmed that science and industry are now in indissoluble partnership, and that further steps should be taken to organise research more thoroughly and efficiently than has been done in the past. We must recognise that, in these days of international competition, the prosperity of every British manufacturer and trader is bound up with that of British trade as a whole, and hence research must be regarded as a national rather than as an individual matter. While admitting the necessity for, and the value of, the research work done by big firms along the lines of their special activities, Sir Robert Hadfield pointed out that there are also a number of questions affecting whole industries the solution of which can be obtained only by the co-operation of many workers investigating special branches of the subject. In these cases everything is to be gained by carrying on the work of research in combination and making its results available to the whole of the organised industry. This is what the Department of Scientific and Industrial Research enables to be better accomplished, at any rate in certain trades and lines of work.

THE third annual Silvanus Thompson memorial lecture of the Röntgen Society will be delivered by Prof. W. H. Bragg in the Barnes Hall of the Royal Society of Medicine, 1 Wimpole Street, at 8 o'clock on Tuesday, March 2. The subject will be "Analysis by X-rays." Admission will be free.

PROF. A. DEPAGE (University of Brussels), Drs. Pierre Duval and A. Gosset (Paris), Prof. J. M. T. Finney (Johns Hopkins University), and Dr. Charles H. Mayo (Rochester, U.S.A.) have been elected honorary fellows of the Royal College of Surgeons of England.

At the recent annual general meeting of the Optical Society Mr. R. S. Whipple was elected to the presidency; Prof. F. J. Cheshire, Sir Herbert Jackson, and Mr. H. F. Purser were elected vice-presidents; Mr. I. G. Aitchison, hon. treasurer; Mr. J. H. Sutcliffe, hon. librarian; and Messrs. W. Shackleton and L. C. Martin, hon. secretaries.

The following officers and council of the Malacological Society of London for 1920 were elected at the annual meeting on February 13:—*President:* G. K. Gude. *Vice-Presidents:* H. O. N. Shaw, T. Iredale, J. R. le B. Tomlin, and A. S. Kennard. *Treasurer:* R. Bullen Newton. *Editor:* B. B. Woodward. *Secretary:* A. E. Salisbury. *Other Members of Council:* A. Reynell, C. Oldham, Major M. Connolly, H. Woods, the Rev. A. H. Cooke, and H. H. Bloomer.

The following officers and members of council of the Royal Astronomical Society were elected at the anniversary meeting on February 13:— *President:* Prof. A. Fowler. *Vice-Presidents:* Sir F. W. Dyson, Prof. A. S. Eddington, Major P. A. MacMahon, and Prof. H. F. Newall. *Treasurer:* Mr. E. B. Knobel. *Secretaries:* Dr. A. C. D. Crommelin and the Rev. T. E. R. Phillips. *Foreign Secretary:* Prof. H. H. Turner. *Council:* Prof. A. E. Conrady, Dr. J. L. E. Dreyer, Dr. J. W. L. Glaisher, Mr. J. Jackson, Dr. Harold Jeffreys, Mr. H. S. Jones, Prof. F. A. Lindemann, Mr. E. W. Maunder, Dr. W. H. Maw, Prof. J. W. Nicholson, Mr. J. H. Reynolds, and Lt.-Col. F. J. M. Stratton.

The war memorial of the Institution of Mining and Metallurgy is to be a sculptured figure, to be placed in the house of the institution, and a record of those who served in his Majesty's Forces. The full scope of the memorial cannot be decided until the council knows the extent of the response to an appeal now being made, but it is hoped that a fund of about 4000*l.* may be available. A member of the institution, Lt.-Col. Peter N. Nissen, has prepared a design for the figure, which has been accepted, as has also his offer to model the figure and friezes. These will be executed in bronze and the pedestal-base in malachite, with four silver-alloy plates upon which an appropriate inscription and the roll of honour will be engraved. This work is already in progress. Members of the institution and others interested in the mining industry are invited to contribute to the war memorial fund. Subscriptions should be sent to the secretary of the institution, 1 Finsbury Circus, London, E.C.2.

The report printed in NATURE of January 8, presented by the Joint Committee of the British Medical Association and the British Science Guild, regarding awards for medical discovery is published in the Journal of the British Science Guild for January. Advances in medical treatment of great value to humanity frequently convey no additional remuneration to the discoverers, and may even involve monetary loss, and it is suggested that rewards should suffice to meet this latter contingency. The principle was accepted by Parliament in the case of Jenner in 1802 and 1807, but the 60,000*l.* annually disbursed by the Government under the Medical Research Committee subsidises only investigations in progress, and not discoveries already made. Honours, medals, and prizes bestowed by H.M. the King or public bodies are acts of grace falling outside the consideration of the committee, which deals with pecuniary reward. It is accordingly recommended that Parliament should provide an annual sum of not less than 20,000*l.*, enabling pensions amounting to between 500*l.* and 1000*l.* a year to be awarded as compensation for losses incurred in achieving medical discoveries.

The annual general meeting of the Institute of Metals will be held in the building of the Institution of Mechanical Engineers, Westminster, on Thursday and Friday, March 11 and 12, under the presidency of Prof. H. C. H. Carpenter. The president-designate is Engineer Vice-Admiral Sir George Goodwin, K.C.B. The following are among the communications to be submitted:—Fifth Report to the Corrosion Research Committee, Dr. G. D. Bengough, R. M. Jones, and Ruth Pirret; The Action on Aluminium of Hard Industrial Waters, Dr. R. Seligman and Percy Williams; Zinc Alloys with Aluminium and Copper, Dr. W. Rosenhain, J. L. Haughton, and Kathleen Bingham; Tin-Phosphorus Alloys, A. C. Vivian; Effect of Hydrogen on Copper, W. C. Hothersall and E. L. Rhead; Influence of Cold Rolling on the Physical Properties of Copper, F. Johnson; Study of Thermal Electromotive Force as an Aid to the Investigation of the Constitution of Alloy Systems, J. L. Haughton; and Idiomorphic Crystals of Electro-deposited Copper, W. E. Hughes. On June 10 (not on May 5, as previously announced) Prof. Carl A. F. Benedicks, of Stockholm, Sweden, will deliver the tenth May lecture, his subject being "Recent Progress in Thermo-electricity."

By the death of Dr. Vincent Arthur Smith at Oxford on February 6 India has lost an eminent historian, archæologist, and numismatist. Born in Dublin in 1848, Dr. Smith was educated at Trinity College in that city, and passed thence into the Bengal Civil Service in 1871, being posted to the United Provinces of Agra and Oudh. He served in this Province until 1900, passing through all the grades of the Service, his last appointments being those of Magistrate-Collector, District Judge, Commissioner, and Secretary to Government. During his service he paid much attention to the local history, archæology, and numismatics, and contributed numerous papers on these subjects to the Journal of the Asiatic Society of Bengal and to the *Indian Antiquary*. On his retirement he devoted his life to historical literature, and wrote a series of valuable works. In "The Early History of India" Dr. Smith for the first time evoked order from chaos, and established the chronology, hitherto uncertain, on a firm basis. This was followed by "The History of Fine Art in India and Ceylon," biographies of Asoka, the Buddhist Emperor, and of Akbar, the Great Mogul, and the Oxford "History of India," from the earliest period down to the present day, which appeared only a few months before his death. In numismatics he investigated the series of Gupta coins, and catalogued the collection of Indian coins in the

Calcutta Museum. Dr. Smith leaves many friends, to whom he was always ready to impart his wide stores of learning, and the charm of his personality will be to them a lasting memory.

An account of the mammals collected in Eastern Cuba during 1917 by Dr. H. E. Anthony appears in the Bulletin of the American Museum of Natural History (vol. xli., art. xx.). Though but a brief preliminary survey of the material collected, this contribution is one of very considerable interest. It forms, indeed, the complement to Dr. Anthony's recent memoir on the indigenous mammals of Porto Rico, living and extinct. Two species of that extinct and extremely primitive insectivore Nesophontes were found, and one of these is new to science. This he has named *Nesophontes longirostris*. The other species, *N. micrus*, bears a close resemblance to *N. edithae* of Porto Rico. Of the Hutias (Capromys), which occur also in Jamaica and Porto Rico, two species were obtained, and several species of bats. All the remains found were from caves, and it would seem that they were deposited in the form of "castings" from the barn-owl. This is a point of some interest, since it helps to explain the great accumulations of small mammal bones found in similar situations in other parts of the world.

The Archives of the Cambridge Forestry Association for 1919 is a brief pamphlet recording the progress of this society since its foundation in October last. The members are mainly past and present students of the School of Forestry, who meet together to promote research and to render assistance in various ways to this important teaching centre. The secretary invites contributions of apparatus, specimens, books, and periodicals to the museum, which is worthy of support, as it already contains a remarkably fine collection of foreign and home timbers, as well as many instructive objects and photographs, illustrating the uses of wood and the diseases, defects, and abnormalities of trees. The income of the school is very meagre, amounting in 1919 to only 57*l*. 13*s*., a sum insufficient to pay salaries and incidental expenses, there being an actual deficit of 123*l*. 1*s*. 4*d*. From this it is evident that there are no funds available for the purchase of apparatus or specimens. The lists of desiderata and of recent additions to the collection given in the pamphlet ought to stimulate donations to the School of Forestry at Cambridge. The other contents consist chiefly of short notes on various objects in the museum, with an account at some length of experiments on the swelling and shrinkage of wood which have been carried out recently by Mr. Herbert Stone. Forestry has lately attracted a great number of students to the universities where the subject is taught, and societies similar to that at Cambridge have been founded during the past year also at Oxford and Edinburgh.

The folding and faulting that characterise the Rocky Mountain belt in Alberta are well shown in the small coloured sections accompanying Memoir 112 of the Geological Survey of Canada (1919) by Mr. J. S. Stewart. The contrast between the region uplifted in Early Eocene times by the "Laramide revolution" and the level or undulating Cretaceous strata to the east is as marked as that between the Juras and the Paris basin. The Oligocene beds in this eastern region represent the river-outwash from the Laramide surface of denudation, and subaerial action in succeeding ages has dissected the country to depths of 2000 ft.

Dr. Charles Schuchert (Bull. Geol. Soc. America, vol. xxix., p. 245, 1918) reviews the stratigraphical position of the American Morrison and the East African Tendaguru formations, which are rich in Dinosaurs. He retains the former in the Jurassic, while suggesting a break in the latter, the lower Dinosaur zone in East Africa being Early Jurassic, and the two main later zones bridging the time from Jurassic to Cretaceous. The discovery of great sauropod Dinosaurs in the south of the late German colony in East Africa dates only from Fraas's work in 1907, and the importance of the deposits is greatly enhanced by the evidence as to age given by the intercalation of strata with marine molluscs. A recent communication to Dr. Schuchert from Prof. Branca in Berlin is mentioned, and may be welcomed as one of the signs of a *rapprochement* between scientific workers.

Bulletin 688 of the United States Geological Survey, on "The Oilfields of Allen County, Kentucky," contains a neat little coloured geological map on the scale of 1/1,000,000 of a very much wider and a very interesting area of oil-producing country in Kentucky and Tennessee, west of the Alleghany range. The folded strata of the great range are included at the south-east angle. The authors, Messrs. Shaw and Mather, describe the occurrences of what are known as oil "sands"—that is, oil accumulations in a variety of rocks in strata of Silurian, Devonian, and Carboniferous age—and believe the original source to have been mainly decaying vegetation. The country dealt with in detail is mainly a gently undulating plainland, with lakelets in sink-holes caused by the solution of the underlying St. Louis limestone, an important stratum of Lower Carboniferous age. The prospector, whose zeal for the discovery of anticlines is now known even on the Stock Exchange, is warned of the occurrence of "pseudo-anticlines" (which, by the way, are true anticlines for the geologist), due to local features of surface-slip and solution.

There is something fascinating in looking across the Hudson from the higher platforms of New York City, and seeing in the uplands of New Jersey the foothills of a country that "needs no embellishment, for in the woods, the streams, the waterfalls, and mountain outlooks Nature has provided the best." We quote from the Report of the Department of Conservation and Development of New Jersey for 1918 (published 1919), which presents a model record of local government and local watchfulness. The director, Mr. Alfred Gaskill, may well be proud of his Department, which has, perhaps, its nearest counterpart in our islands in the Department of Agriculture and Technical Instruction for Ireland. One

of Mr. Gaskill's Boards proposes the reservation of a mountain-park, where summer camps and children's playgrounds can flourish along thirty-six miles of practically uninhabited country; the geological division conducts soil surveys in lands where profitable patches require indication; it also presides over matters of water-supply, and, curiously enough, over the State Museum, with its permanent and loan educational collections; and the forestry division furnishes admirable illustrations of trees in relation to highways, and of the necessity for maintaining its reserves. It is characteristic, and due to climatic conditions, that the Fire Warden's report should be a considerable feature in this attractive little volume. The use of glauconitic marl as a source of potash is now in the hands of the Spilsbury Engineering Co., of New York, which proposes to produce 100 tons a day of a chemical extract the nature of which is not specified.

FROM Freiburg-im-Breisgau, the picturesque Rhine town that so often suffered in return for the savagery of German air-raids, there comes once more the *Berichte* of the local *naturforschende Gesellschaft* (Bd. xxii., Heft 1, 1919), which in happier years maintained our scientific knowledge of the Rhinelands. This part is devoted to a fourfold disquisition ("Vier Kapitel") by Prof. W. Deecke on petrographic subjects, the first section being on "Konglomeratbildung." A number of points commonly overlooked in teaching are shrewdly emphasised, such as the necessity for a hollow of erosion or of sinking for the accumulation of a big pebbly mass, and for some form of almost contemporaneous cementation if the conglomerate is ultimately to be preserved. In the section on the "Diagenesis" of sediments Prof. Deecke points out that under varying conditions subaqueous sediments are preserved from remote ages as loose material (the sands with bucklered ganoids of Dorpat are an instance), or as consolidated and resisting rocks. The influence of heat and pressure on gels in the interstices between the grains leads to firm cementation, as when iron hydrates pass into magnetite, and garnet develops from calcium carbonate, quartz, and kaolin by removal of water from the mixture. Next, the mystic words of Suess, "Sal" and "Sima," are critically discussed; the author remarks that there is a "good form" even among geologists (do we not know it in university circles?), which maintains the use of such terms beyond their true importance. Dr. Holtedahl's essay on these magmas was referred to in NATURE of January 29, p. 574. Lastly, we have an excellent review of fossil reef-formation, in which the tendency of similar conditions to produce similar groupings of animal types is excellently impressed upon us.

ENGLISH mining engineers may be interested to find that the flotation process is beginning to attract attention in France, as is shown by a lengthy article on the subject in the *Revue générale des Sciences* for January 15, though it must be admitted that the information therein given is far from being either up-to-date or quite trustworthy. It seems curious that so recent an article should make no mention of Sulman's important contribution to the theory of flotation read before a meeting of the Institution of Mining and Metallurgy in November last, the French author being apparently quite unaware of it. It is strange to read two months after the publication of so exhaustive a treatment of the subject that "the time still appears far distant when a theory capable of explaining the observed phenomena can be established." Whilst his knowledge of the theory of the process is thus defective, the author of the article in question commits not a few errors in regard to its technology. It is scarcely correct to say that flotation is applicable only to ores carrying sulphides, and English readers will be interested to learn that the Murex process is stated to have been devised by an inventor of that name!

THE Canadian Department of Mines has issued the statistics of the mineral production of Canada for 1918 in two reports, one devoted to coal and coke, the other to the metals. The former is, perhaps, the more interesting in view of the immense importance to the whole world of coal output at the present moment. It is pointed out that the term "coal production" is used in a perfectly definite sense, namely, the total of coal sold *plus* coal used by the producers, and this must not be lost sight of in comparing Canadian production with that of other countries, *e.g.* Britain, which latter includes coal lost or unsaleable and coal put into stock. The Canadian production was 13,373,148 statute tons, as compared with 12,541,749 tons in 1917; there were employed 25,419 men, whose average earnings for the year were 1294 dollars (or 270*l.* at par), equal to 2.46 dollars or 10*s.* 3*d.* per ton. It should be specially noted that the output per man was 526 tons for the year—a figure that contrasts most favourably with the British figures. The colliery consumption and coal supplied to workmen amounted to 9·6 per cent. of the production. Of the more important metals, the copper production was 118,769,434 lb., the highest ever attained; the production of lead was 51,398,002 lb., the highest since 1906; of nickel, 92,507,293 lb., the highest ever recorded; the silver production was 21,383,979 oz., a falling-off of 3·7 per cent. as compared with 1917; and the gold production was 699,681 oz., or 5·3 per cent. below that of 1917.

MAURITIUS meteorological, magnetical, and seismological records are issued in the monthly and annual reports of the Royal Alfred Observatory, under the directorship of Mr. A. Walter. The annual report for 1918 and the monthly reports to August, 1919, have been received. Continuous photographic registration is made of atmospheric pressure, temperature of the air and evaporation, and automatic registration of direction and velocity of wind, of rainfall, and of bright sunshine. The photographic registrations have been checked at regular intervals by eye observations, and daily observations are made of terrestrial radiation and of thermometers ranging from 3 in. to 118 in. below the surface soil. Monthly, quarterly, and yearly departures from the normal are given for the several elements. In 1918 the temperature of the air was

below the normal in all months except December. The defect was marked in July, August, and September. During 1918 a daily journal of the weather over the Indian Ocean was kept by means of observations obtained from ships' log-books. The logs of sixty voyages were copied. So far as is known, there were five cyclones in the South Indian Ocean during the year 1918. The daily records of observations published each month are of considerable value in adding to our knowledge of the physics of the globe. Epochs of diurnal range are regularly shown by the several instruments. The velocity of the wind at the Mauritius Observatory is seen to increase very regularly at the midday hours and to fall off during the night, the range frequently being shown even on days when the normal trade winds are interrupted. The seismograms record sixty-seven earthquakes during 1918.

THE January number of the "Abstracts of Papers" issued by the Institution of Civil Engineers contains 235 pages, twelve of which are devoted to name and subject indexes. The abstracts, of which there are 387, are classified under the six heads: Measurement, Materials, Structures, Distribution of Energy, Appliances, and Specialised Practice. Each head is, as a rule, subdivided into sections. It is impossible to read through the abstracts without realising the importance to the future of the engineering profession in this country of a knowledge of the progress which is taking place in the practice of engineering throughout the world. From the number of abstracts devoted to it, the question of fuel economy appears to have been taken up with vigour in America and in Germany. In the former country the use and advantages of pulverised low-grade coal have been investigated, and it appears that 75 to 80 per cent. efficiencies can be obtained with it in boilers of all sizes. In Germany the utilisation of the waste heat from iron and steel furnaces to generate steam in boilers is being strongly advocated as the best form of economy.

THE reviewer of part i. of "The *Daily Telegraph* Victory Atlas of the World," in NATURE of November 13, 1919, remarked, towards the end of a favourable notice: "The changes due to the Peace Treaty are incorporated, but a mistake is made in the area of the Slesvig plebiscite." The publishers of the map, Messrs. Geographia, Ltd., wrote at the time to say that the boundary shown on their map was correct. The reviewer's comment, as stated in our issue of December 25, p. 419, was based upon the abstract of the Treaty of Versailles, and the recent publication of the Treaty has enabled him to compare its wording with the large-scale map of Slesvig. He now writes to acknowledge the correctness of Messrs. Geographia's map in this respect, and to apologise for his mistake. We on our part much regret that, on a point of fact, a review in our columns should have contained a statement which now proves to be in error, and that, in consequence, the accuracy of a particular frontier line on Messrs. Geographia's production was wrongly questioned.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press "The Theory of Direct-current Dynamos and Motors: A Text-book for University Students of Electrical Engineering," by J. Case, which has been written to fill the gap between books of general electrical engineering and the specialised ones dealing with designs. The aim has been to furnish the student with a fairly comprehensive study of the principles and theories underlying the design of direct-current dynamos and motors, and the work will contain many worked examples; also exercises for the student. The notation adopted is that of the International Electrotechnical Commission.

MR. C. BAKER'S classified list (No. 68) of second-hand scientific instruments includes in one of its sections a number of microscopes and accessories which should be of particular interest at the present time to students and other workers. There are also sections on surveying and astronomical instruments, spectroscopes and projection apparatus, and other instruments.

MR. L. T. HOGBEN wishes to direct attention to an omission in the abstract of his Royal Society paper, "Studies in Synapsis," i., reprinted in NATURE of February 12 (p. 649). He does not conclude that abortive spindles characterise the Hymenoptera in general, but only the Hymenoptera parasitica.

OUR ASTRONOMICAL COLUMN.

MERCURY AS AN EVENING STAR.—This planet will reach its greatest easterly elongation (18° 11′) on March 3, and set at about that date rather more than an hour and three-quarters after the sun. This will be the most favourable period of the year for viewing Mercury in the evenings. The intending observer should look towards the east-by-south region of the horizon, and when the atmosphere is clear the planet will be seen about an hour after sunset at a low altitude. It will set on February 26 at 7.5 p.m., on March 4 at 7.31 p.m., and on March 11 at 7.23 p.m.

CENTENARY OF THE ROYAL ASTRONOMICAL SOCIETY.—At the annual general meeting of this society held on February 13, the president, Prof. A. Fowler, gave an address on the foundation of the society just a century before. The four men who were most influential in its formation were the Rev. William Pearson, Mr. Francis Baily, Sir John F. W. Herschel, and Mr. Charles Babbage. The two latter both lived until 1871, and there are no fewer than fifteen surviving fellows whose fellowships overlapped with theirs. One of these, Mr. Inwards, said that he remembered speaking to Sir John Herschel at a meeting of the society. There was at first a good deal of opposition to the new society on the part of the Royal Society, and the Duke of Somerset, who was elected the first president, quickly resigned this office owing to the pressure brought to bear upon him. He was succeeded after an interval by Sir William Herschel, who was then eighty-two years of age, and died in 1822. Mr. Stephen Groombridge, well known for his Star Catalogue, was another of the original members. They were not called fellows until 1830, when the Royal Charter was granted, giving the society its present title; it was previously called the London Astronomical Society. The earliest publications of the Society were in the form of memoirs; the Monthly Notices did not commence until several years later, and were at first only small pamphlets containing ephemerides of comets and other matters of transient interest.

IS VENUS CLOUD-COVERED?—Mr. Evershed has taken many photographs of the spectrum of Venus in recent years, for the purpose (*inter alia*) of endeavouring to detect the Einstein shift, and of testing his own hypothesis that the earth has an effect on the atmospheric circulation of the sun. In the course of this work he found, to his surprise, that a much longer exposure-time was needed than was the case in photographing the spectrum of a cumulus cloud on which the sun was shining (Monthly Notices R.A.S., November). Mr. Evershed expected the time to be shorter, for the intensity of sunlight on Venus is 1·92 times as great as on the earth. Allowing for the absorption of Venus's atmosphere, he concludes that if Venus were covered with clouds similar to our cumulus clouds, the exposure-time would be less on the former than on the latter in the ratio of 1 to 1·3, whereas the contrary is the case. He concludes that the atmosphere of Venus is not cloud-laden, but that its lower strata contain much dust in suspension, veiling the surface features. This conclusion is similar to that reached by Prof. Lowell from his observations at Flagstaff.

Mr. Evershed thinks that the values of the colour-indices assigned by Prof. H. N. Russell to the sun and Venus (+0·79m. and +0·78m.) are mutually inconsistent, since they imply that no selective absorption takes place in Venus's atmosphere. Mr. Evershed finds evidence of decided selective absorption in the violet, as compared with his cloud spectra.

PROFESSIONAL METEOROLOGY.

SIX parts of the new Professional Notes of the Meteorological Office have now been issued. The first[1] deals with the relation between cloud and wind direction at Richmond, and gives tables for each month for 10h., 16h., and 22h. for fifteen years, showing the number of times each cloud amount was associated with each wind direction or with calms; it would perhaps have been clearer if percentage values had been given. Several important points come out, such as the well-known tendency of cloud to disperse at night, but it is also shown that this tendency is not the same for all winds or for all seasons. Cloud forecasting became important during the war, and will in future be of wide application; it is to be hoped, therefore, that Lieut. (now Capt.) Brunt will fulfil his intention of continuing this research. Tables also give values for Greenwich for January and July, and various differences from Richmond are apparent; Richmond had only 59 calms in 180 months, while Greenwich had 58 in 20 months, which indicates, perhaps, a difference in estimating light winds. Greenwich had more south-west and fewer south and north-west winds than Richmond, due probably to local exposure.

It would be more satisfactory to compare cloud amount with wind at cloud-level or with gradient direction, for Mr. Newnham's paper[2] on a night valley wind shows that surface winds may be shallow and more or less unrelated to upper-air phenomena. Cold air flows down valleys at night in radiation weather, and if, at so open a station as Benson, the wind at night sometimes blows "very steadily from east-by-south to east-south-east regardless of what the direction had been during the previous day," the need for caution in dealing with surface winds is obvious. But in the case of fog it is the surface wind that is of importance, as appears in Mr. Brooks's paper[3] on the fog in London on January 31, 1918, when the incidence of the fog seems to have been influenced by "shallow streams of cold air flowing down the sides of hills." The isobaric maps in this paper show a bend in the isobars over the Thames estuary which Mr. Brooks thinks is real, but possibly exaggerated "by slight inaccuracies in some of the barometer readings." Those who draw isobars know how peculiar are some of the readings, and would welcome a future Professional Note on these peculiarities.

A vast amount of information was obtained during the war on upper-air temperatures and winds, and it would be a real loss to meteorology if this were unused or lost. Lieut. Stacey and Capt. Chapman are therefore to be congratulated on having made use of some of these records. Lieut. Stacey[4] deals with upper-air temperatures at Martlesham Heath from February, 1917, to January, 1918, and sets out the information clearly on the whole, though several misprints are noticeable. Unfortunately, "no information is to hand of the type and exposure of the instruments used," which is to be regretted, especially as one would suppose such information could have been obtained; as a matter of fact, the thermometers were exposed on the wing-struts of the aeroplanes, but the type of thermometer varied from time to time, and therefore the early records are probably not strictly comparable with the late ones; but these facts are not recorded in the paper. It is very desirable that all details of meteorological war-work should be collected before it is too late to obtain them.

Capt. Chapman[5] reviews formulæ connecting increase of wind velocity with height. Many of the early ones were linear, but linear formulæ are unlikely, and were probably only intended as working guides until more observations were available. From a consideration of many observations, including 190 in north-eastern France, the author deduces the formula $V = a \log H + b$ (where V is the wind velocity, H the height, and a and b are constants), which fits most of the observations below the height at which the mean gradient velocity is reached. The whole paper deserves careful study. In another publication[6] Capt. Chapman discusses the normal curve of errors in connection with what meteorological observations should be classified as unusual or exceptional.

Meteorology has advanced rapidly in recent years, and these publications, and others, show that the advance in this country is due largely to the Meteorological Office, and it is to be hoped that its future activities may not be hampered by the proverbially unscientific attitude of Government Departments.

STEAM BOILERS AND ECONOMISERS.

AS chief engineer of the Manchester Steam Users' Association Mr. C. E. Stromeyer prepares a yearly memorandum. The memorandum for the year 1918–19 deals with fuel economy and with economiser and furnace collapses. Some industries require much power and little steam for heating and boiling; others much steam and little power. If two such industries could combine, the cost of 1 h.p. could be reduced from, say, 2 lb. of coal to ½ lb. If, for instance, a spinning mill consumes 20 tons of coal

[1] "On the Inter-relation of Wind Direction and Cloud Amount at Richmond." By Lieut. David Brunt. (Meteorological Office, 1918.) Price 3*d*.
[2] "Notes on Examples of Katabatic Wind in the Valley of the Upper Thames at the Aerological Observatory of the Meteorological Office at Benson, Oxon." By E. V. Newnham. (Meteorological Office, 1918.) Price 3*d*.
[3] "Incidence of Fog in London on January 31, 1918." By C. E. P. Brooks. (Meteorological Office, 1918.) Price 3*d*.
[4] "Upper-Air Temperatures at Martlesham Heath, February, 1917, to January, 1918." By Lieut. W. F. Stacey. (Meteorological Office, 1919.) Price 1*s*.
[5] "The Variation of Wind Velocity with Height." By Capt. E. H. Chapman. (Meteorological Office, 1919.) Price 1*s*.
[6] "On the Use of the Normal Curve of Errors in Classifying Observations in Meteorology." By Capt. E. H. Chapman. (Meteorological Office, 1919. Price 6*d*.

for power alone, and a sugar factory an equal quantity of coal for boiling purposes, some means ought surely to be found to bring them together, and thus satisfy both demands with a consumption of 23 tons instead of 40 tons.

In discussing the question of the safety of cast-iron economisers, Mr. Stromeyer gives a summary of all the economiser explosions—seventeen in number—reported upon by the Board of Trade since 1882. Only nine of these explosions were destructive, but, unfortunately, none of the inquiries into these mishaps have revealed their true causes. If the Board of Trade inquiries into boiler explosions are to be of value, they ought to be conducted in such a manner that the study of the reports may be of service to engineers who have to design and use the appliances. It would appear, however, that the object which Mr. Stromeyer's association had in view in drawing up the Boiler Explosions Act, 1882, has been entirely lost sight of. It was intended that every explosion should be investigated by an expert, but it was found necessary, in order to get the Bill through Parliament, to add one competent lawyer to the engineering experts. The lawyer has always been made president of the commission, with results which may be imagined. Further, there are probably very few "competent and independent engineers" who are, as required by the Act, "practically conversant with the manufacture and working of boilers," since few engineers pass through the boiler-shop, and fewer still have had to work them. But the Board of Trade has no hesitation in appointing men to make these inquiries who have never even seen the objects which they have to investigate. At a recent inquiry two investigators, both marine engineers, confessed that they knew nothing about land economisers, neither their design, material, manufacture, nor mode of working. As the Board uses a rota, the chances are that these engineers will never again be called upon to inquire into an economiser explosion, despite the knowledge they doubtless gained in the course of the inquiry. In these circumstances it is but natural that many preliminary reports, and nearly all Commissioners' reports, dismiss the cause of explosions with a non-committal remark to the effect that "the boiler burst because it could not withstand the steam pressure."

Mr. Stromeyer suggests, and we strongly support the suggestion, that the duty of investigating boiler explosions should be entrusted to an enthusiastic engineer, who would certainly go into details, and make experiments on the strengths of materials, especially upon the parts of burst boilers, which is scarcely ever done at present; he would also take steps to become acquainted with the influences of working conditions.

The memorandum contains ample evidence, extracted from Board of Trade reports, to justify Mr. Stromeyer's remarks. For example, Report No. 2470, on an economiser explosion, omits to mention certain old fractures. The two "competent and independent engineers" (selected by the Board from among its own staff), together with other engineers, refused in their evidence to admit that an open damper could have caused the failure of any of the pipes, and attributed the explosion to the old fractures. By withholding this information the report deprives the engineering profession of the means of studying the problem of economiser safety.

The fact appears to be that the investigations are carried out by the solicitor of the Board of Trade, who brings forward sworn evidence, though the swearing is not required by the Act, and without any warning to the witnesses, these may now be cross-examined both by their own side and by the Commissioner, and then very often their own sworn evidence is used against them. It is unfair to witnesses who wish to give the Commissioners every assistance, and as the whole atmosphere is now a legal one (even a Lord Advocate once appeared for an insurance company) the technical causes of explosions are scarcely inquired into.

THE BELGIAN ROYAL OBSERVATORY.

IT is pleasant to see that the Brussels Observatory is in a position to resume the publication of its memoirs (Annals of the Belgian Royal Observatory, vol. xiv., part 2). After a discussion of the division errors of the Repsold meridian circle, Prof. Stroobant contributes an interesting essay on the constitution of the ring of minor planets. Tables and diagrams are given of the distribution of the various elements; the striking grouping of the perihelia towards Jupiter's perihelion is already well known, and Newcomb gave an explanation of it from theory. The eccentricities show a similar grouping, high eccentricities being most frequent in the quadrants where the perihelia congregate; this can also be explained by the action of Jupiter. The formulæ expressing the perihelion density (N is the number of perihelia in an arc of 30°) and the eccentricity are:

$$N = 66{\cdot}75 - 31{\cdot}7 \sin(\varpi - 106{\cdot}7^{\circ})$$
$$e = 0{\cdot}141 - 0{\cdot}028 \sin(\varpi - 86{\cdot}5^{\circ}).$$

The ascending nodes show a slight tendency to group towards Jupiter's ascending node; it would probably be easier to study the relations of nodes and inclinations if the elements were referred to the plane of Jupiter's orbit rather than to the ecliptic.

There is an interesting study of the probable total number of asteroids brighter than magnitude 20. From some very faint asteroids discovered by photography at the Lick Observatory, combined with the area of sky covered by the plates, the total 57,000 is obtained. From a study of the number of known planets of different magnitudes the empirical law is deduced that the number per magnitude doubles for a fall of one magnitude. On this basis the total number brighter than magnitude 20 is 100,000. The two estimates are in satisfactory accordance, bearing in mind the large measure of extrapolation employed in each method.

It is estimated that very few asteroids (say twenty) brighter than the 12th mag. at opposition remain to be discovered.

Taking the mean albedo as 0·108 (midway between those of Mercury and Mars) and the density the same as the moon's, the total mass is 1/22 of that of the moon, the planets brighter than magnitude 10 contributing one-third of this total, and those between magnitudes 10 and 11 another one-third.

The third memoir in the volume is on the brightness, colour, position, and parallax of Nova Aquilæ; a large-scale light curve is given extending from 1918 June 10 to November 23. From the end of June until the middle of August there were fairly regular oscillations in the curve, the period being thirteen days. Prof. Stroobant notes two cases of apparent rapid change of light. On August 29 the brightness increased 0·7 mag. in twelve minutes; on October 6 it fell 0·3 mag. in five minutes. Changes like this need verification from more than one station to make sure that they are not due to a local variation in the transparency of the air.

The position and parallax were obtained by observations with the meridian circle. Screens of muslin were placed over the object glass for the brighter stars. The thickest screen reduces the light by

3·2 mag. Two determinations of the parallax are given:

(1) 0·20″ ± 0·05″ M. Philippot.
(2) 0·06″ ± 0·07″ M. Delporte.

Both determinations appear to be improbably large, judging by the small proper motion and the values obtained for other novæ.

A. C. D. CROMMELIN.

THE LIVERPOOL MARINE BIOLOGY COMMITTEE.[1]

THE issue of the thirty-third annual report of the Liverpool Marine Biology Committee, and, as we are informed, the last of the series, is an opportune moment for the publication of a review of the important work that has been done since the formation of the committee in 1885. This report is not the swan-song of a dying enterprise, but rather the triumphant cry of those who have achieved an initial victory that gives hope for a rapid and continuous advance in the future; and, although the old L.M.B.C. ceases to exist, there is every reason to believe that its work will be carried on with increased efficiency by the newly organised staff of the oceanography department of the University of Liverpool.

In the short history of the work of the committee that is published in this report it is clear that a very substantial contribution has been made to our knowledge of the species of animals and plants that inhabit the waters of the Irish Sea, and that valuable information has also been acquired about the many characters of the sea-bottom round the Isle of Man and the north coast of Wales.

All this is necessary pioneer work, although much of it may seem dull and uninteresting when in print. The workmen must learn the use of their tools before undertaking the more serious work of production. But we see in the L.M.B.C. memoirs, of which twenty-three have already been published, in the important investigation of Prof. Herdman and his colleagues on the fluctuations of the plankton, and in the biochemical researches of Prof. Moore and others, that these valuable contributions to our scientific knowledge of the sea have outgrown the "Records" of the early years of the life of the committee.

The work of recording and describing the booty of the sea must, of course, continue; but with the ripe experience of thirty-three years, with the more complete equipment of laboratory space and apparatus, and with the new organisation of the oceanography department of the University, we may confidently look forward to further important developments in the general scientific work of the Port Erin institution.

We may tender to Prof. Herdman our cordial congratulations on his achievements in the past and our good wishes for the full success in the future of the great enterprise which is so largely due to his own personal genius and enthusiasm. S. J. H.

APPLICATIONS OF INTERFEROMETRY.

IN a report by Prof. Carl Barus, of Brown University, recently published by the Carnegie Institution of Washington, a number of interesting applications of achromatic interferometry are described. In the first chapter a method of measuring small angles is discussed. The general theory of the subject is developed at some length, and a variety of interferometer devices, with mirror, ocular, and collimator micrometers, are instanced. As the achromatic fringes cannot (in general) be found without first finding the corresponding spectrum fringes, the second chapter is devoted to spectrum fringes. The work described in the third chapter was undertaken at the request of Prof. W. G. Cady, in the endeavour to obtain the elastic constants of small bodies. The application of the displacement method proved astonishingly easy in a case where a degree of rough handling is inevitable, but it was found that there lurked in the elastic apparatus some discrepancies, both of viscosity and hysteresis, the nature of which escaped detection after many attempts to locate its origin. The fourth chapter contains applications of the rectangular interferometer using achromatic fringes to the study of gravitation. A method for the determination of the Newtonian constant is worked out. Again, the same interferometer is associated with the horizontal pendulum for the detection of small changes in the inclination of the earth's surface. Series of observations extending between January and August are recorded. In the fifth and last chapter the author deals with the application of interferometers to the study of vibrating systems. To test the method, an examination is made of the vibration of telephonic apparatus. Interference-vibration curves have been obtained for two identical telephonic systems joined directly in series, while these forms subsided completely when the telephones were joined differentially.

RESEARCHES AT HIGH TEMPERATURES AND PRESSURES.

BY THE HON. SIR CHARLES A. PARSONS, K.C.B., F.R.S.[1]

I.

JUST ten years ago in this room Sir Richard Threlfall discussed the effects of temperature and pressure on various substances, and commenced by referring to a suggestion I made in 1904 to sink a bore-hole twelve miles deep in the earth with the object of exploring the region beneath us, about which so little is known. Last summer at Bournemouth I ventured again to direct attention to the desirability of such an exploration in the interests of science generally, and to the possibility that it might ultimately lead to some developments of practical importance and utility.

Ten years ago no experiments had been made on the behaviour of rocks under the conditions existing at great depths below the surface of the ground; but, prompted by my suggestion in 1904, and after some subsequent correspondence in regard to the possibility of the rock crushing in and closing the shaft, Prof. Frank D. Adams, of McGill University, Montreal, commenced experiments on the strength of rocks to resist the closing up of cavities under the conditions prevailing at great depths below the surface. He published the account of these experiments in the *Journal of Geology* for February, 1912.

Adams's method was to place a block of granite or limestone in a tightly fitting cylinder of nickel-steel, which was shrunk lightly around the block to ensure perfect fitting and support; hard steel rams actuated by a hydraulic press were arranged to exert a known pressure against the ends of the block. Two small holes were previously drilled in the specimen, one axial in the centre and one transverse, the diameter of the holes being 0·05 in., or one-tenth the diameter of the specimen. The temperature of the container and specimen was maintained at any desired point up to the softening point of steel. In some experiments no heat was applied, while in others the temperature

[1] The Marine Biological Station at Port Erin. Thirty-third Annual Report of the Liverpool Marine Biology Committee. Drawn up by Prof. W. A. Herdman. Pp. 84. (Liverpool: C. Tingling and Co., 1919.)

[1] Discourse delivered at the Royal Institution on Friday, January 23.

was raised to that estimated to exist at the depth below the surface of the earth corresponding to this pressure.

When no heat was applied the holes in the granite showed no alteration under a pressure equivalent to thirty miles deep, and in the case of limestone the specimen supported one-half of this pressure without alteration. Adams then raised the temperature of the container and specimen. When granite was heated to 550° C., a temperature corresponding to eleven miles below the surface, it stood a pressure equivalent to fifteen miles, and might have stood more but that the container became weakened by the heat. Limestone begins to decompose at a temperature of 450° C., but even at this temperature it withstood a pressure corresponding to ten miles.

Adams concludes that small cavities in granite will not close in under the conditions of pressure and temperature at eleven miles below the surface, however long a time is allowed to lapse, and that the cavities may persist to much greater depths, but the softening of the steel of the container precluded the carrying of his experiments to still higher temperatures and pressures.

So far as they go, these experiments are reassuring as to the permanence and safety of a pit shaft twelve miles deep sunk through granite, but it would be more satisfactory to experiment on a larger specimen than one only $\frac{1}{2}$ in. in diameter as used by Adams, and to heat the specimen electrically when submerged in graphite while keeping the container cold, the temperature being indicated by a thermo-couple in the specimen. This could be carried out in a nickel-steel container like that shown in Fig. 2.

In this connection P. W. Bridgeman in 1911 submerged a sealed glass tube containing a cavity under an external hydrostatic pressure of 24,000 atmospheres (corresponding to a depth in the earth of fifty-six miles) for three hours, and the cavity showed no change in size or form. It, however, appears that temperature will probably place a limit to the depth that could be reached before the closing in of the shaft commences to occur, for Judd, Milne, and Mallet agree in the view that the deepest origin of earthquakes is between thirty and fifty miles. This would seem to indicate that at greater depths than thirty miles the temperature and pressure are such that changes of form take place by plastic deformation, and not by sudden slips or the formation of faults, which are the chief cause of earthquakes. Again, Oldham states that beyond twenty miles deep seismic waves which are transmitted by compression and distortional vibrations change in character in this respect: that though the compressional waves are only slightly affected in velocity, on the other hand the distortional waves are reduced to one-half their velocity. This would seem to imply that the modulus of elasticity in shear has, at twenty miles depth, owing to the rise of temperature, fallen to one-half, and it seems probable that the rock also is weakening in its resistance to shear; in fact, that the rock is becoming more plastic, and that cavities would probably close up at twenty miles below the surface.

The greatest depth to which a shaft has as yet been sunk is only about $1\frac{1}{3}$ miles. The deepest single-stage shaft on the Rand is that of the Hercules East Rand Proprietary Mine. It is 4500 ft. vertically, and rectangular in section. The deepest shaft in the world is that at Morro Velho, Brazil. The bottom is 6400 ft. vertically below the surface, and it has been sunk, and is worked, in stages, two of which are about 1200 ft. vertical. The deepest shaft designed on the Rand is by the City Deep Co. It is 7000 ft. vertically, is circular of 20 ft. diameter, and is to be worked in two stages of 3500 ft. each. The most rapid sinking record was made at the Crown Mines No. 15 Shaft, where 310 ft. were sunk in a month; the shaft is circular, and of 20 ft. in diameter.

There are several interesting departures from ordinary mining practice necessary. The haulage is arranged in stages of about half a mile, principally in order to economise the weight of rope and also the power for winding. In countries where the atmosphere is dry the sides of the shaft are cooled by sprinkling water upon them, which by evaporation cools the rock. It is, however, possible to augment this effect by artificially drying and cooling the air before passing it down the mine.

When still greater depths of shaft are in contemplation further methods of cooling in addition to these would probably be found necessary; for instance, the carrying of the heat upwards by means of brine circulated in a closed ring formed of steel pipes with a rising and descending column. Though the columns might be carried the whole depth of twelve miles, the hydraulic pressure at the bottom would be about 12 tons per square inch, and entail very costly pipes of great strength to resist the pressure. A cheaper plan would be to work in stages, each ring covering a stage of from two to three miles of the shaft, the heat being transferred from the top of one brine ring to the bottom of the ring above by surface-heat exchangers and refrigerating machinery to neutralise the heat drop on transfer. These may be called heat pumps, and would be driven electrically.

As the depth of the shaft increases, the pressure of the air upon the miners will be about doubled for every three miles, but what is more serious is the increase in temperature of the air itself caused by the adiabatic compression due to gravity, by which it will be raised about 100° F. For these reasons it will be necessary to place airtight partitions across the shaft at every mile or two, and to carry on the ventilation through these by means of a pump to deliver the foul air upwards and an expander to allow the fresh air to descend. These two machines would be linked together, and the difference in their power supplied by an electric motor. (This method has been often used with water, and is equally applicable to air.)

At each partition heat exchangers and refrigerating machinery similar to those used for the brine would be placed. Another and preferable plan would be to place numerous heat exchangers between the ascending columns of air to transfer heat from one to the other. The air would, in this case, not itself act as a conveyor of heat to the surface, for which the brine columns would be depended upon, but it would enable airlocks every three miles to suffice. A further alternative and very simple method would be to convey liquid air from the surface, and allow it to escape at the part of the shaft requiring cooling. It would ensure good ventilation.

When sinking the deeper portions of the shaft, shields would probably be necessary to protect the miners from the splintering of the rock which is caused by the intense compressive stress, which splits off scales from the surface, sometimes with considerable violence.

In 1904 the estimate of the time required to sink twelve miles was eighty years, and was based on the records of that time. With improved machinery and methods the records have been so much lowered that an estimate of thirty years seems now to be reasonable.

Threlfall traced the gradual evolution of the theory of the effects of temperature and pressure on the allotropic forms of various substances. He described his

apparatus and experiments designed to melt graphite under high pressure, his inference then being that under pressures up to 100 tons per square inch carbon does not follow the same law as many other substances, and does not crystallise as diamond on cooling.

An interesting discovery was made by Bridgeman in 1911 when studying the compressibility of mercury. He found that it had a remarkable power of penetrating steel containers, a power not possessed by oil or water, which caused them to burst at much lower pressures than when they were charged with oil or water. The phenomenon he attributed to the fact that mercury has the power of dissolving small percentages of iron, and will amalgamate with it when the surfaces are absolutely free from oxide.

In 1912 Bridgeman published his remarkable researches on water under pressures up to 20,000 atmospheres. He found that there are four allotropic forms of ice besides ordinary ice, which are found under various conditions of pressure and temperature with determinate regions of stability. All these forms except ordinary ice are more dense than water; one is remarkable as existing from a temperature of −18° C. under a pressure of 4500 atmospheres up to a temperature of 67° C. under a pressure of 20,000 atmospheres.

Recently a pressure of from 200 to 1000 atmospheres at a temperature between 500° and 700° C. has been applied to compel hydrogen to combine with nitrogen to form ammonia on a great commercial scale, a catalyst being necessary to promote the combination and to establish the equilibrium between the gases and their product. This action is reversible as regards temperature and pressure. On the other hand, iron just molten is an energetic catalyst in the transformation of diamond into graphite, but, contrary to expectations, as we shall see, no amount of pressure that has yet been applied appears to have caused a reversal of this action.

More than thirty years ago, having suitable apparatus at hand, I made a few experiments to try the effect of high pressures and temperatures on carbon, compounds of carbon, and some other substances.

The apparatus consisted of an 80-ton press, under which suitable containers were placed, and a turbo-generator of 24 kilowatts output at 80 volts provided the current. It had been discovered by Cheesborough that the carbon filaments for incandescent lamps became very hard and resilient when heated in a hydrocarbon atmosphere of about 4 mm. absolute pressure, and I was anxious to try what would be the result if a rod of carbon were electrically heated when submerged in a liquid hydrocarbon under high pressure. Benzine, paraffin, treacle, chloride, and bisulphide of carbon were tested under a pressure of 2200 atmospheres, or about 15 tons per square inch. The results were not successful in producing a hard coating to the rod or in increasing materially its density and hardness except in the case of tetrachloride of carbon, which slightly consolidated and hardened it; on the contrary, the carbon deposited from the liquids always appeared as soft amorphous carbon like soot. These experiments were extended by substituting, instead of the liquids mentioned, silica, alumina, and other substances and increasing the pressure to 30 tons per square inch. When the current density was sufficiently increased the rod was converted to soft graphite. Moissan in 1003 expressed the view that iron in a pasty condition was the matrix of the diamond, and that great pressure was the determining factor, which compelled a minute fraction of the carbon present to appear as diamond; he further referred to the probability of carbon being liquefied when under a pressure sufficient to prevent its volatilisation, and that from the liquid state it may pass into the crystalline form on cooling. Crookes, in his lecture delivered before the British Association at Kimberley in 1905, emphasised the same view as to the probability of the crystallisation of carbon directly from the molten state on cooling.

Though my original experiments in 1888 were not favourable to these views, it nevertheless seemed desirable to carry the investigations up to the greatest possible pressures attainable. Experiments were, consequently, resumed in 1907 with a new equipment, which consisted of a 2000-ton hydraulic press and a storage battery of 360 kilowatts output. The battery can be coupled for 2, 4, 8, 16, or 48 volts as required, and the mains and the main switch can carry currents up to 80,000 amperes to the hydraulic press, which is placed by itself in a small, strong house partly below ground, with walls of 2 ft. thickness reinforced with steel bars; the door is of steel 3 in. thick, and the roof is of light galvanised iron. The container under the press is further enclosed by 2 in. thick telescoping steel rings, raised into position by steel ropes and counter-weights. These precautions, as experience showed, were necessary, as several violent explosions occurred which cracked the steel rings and blew off the roof. A charge of iron and carbon, when confined and raised to a high temperature, may be very violent if suddenly released by the melting of the pole-pieces; also some endothermic compounds have been formed which swelled the container and allowed the contents to escape.

My experiments confirmed the conclusion at which Threlfall had independently arrived: that under pressures up to 100 tons per square inch and very intense heating by electrical current, graphite is not materially changed. But modifications in the experiments were made and other methods adopted, as will be explained, which in some respects carried the investigation to still higher pressures and temperatures; these, however, lead to the same conclusion.

I propose this evening to deal chiefly with the practical or engineering side of the subject, and to review the limits of pressure and temperature which are artificially attainable, and to make some comparison between them and the pressures and temperatures occurring in Nature.

When the blade of a knife is pressed strongly against another blade so as to make a dent in each, the pressure on the boundary surface of the metal at the notch will have averaged from 300 to 350 tons per square inch, according to the hardness of temper of the steel. The pressures on the knife-edges of a weighing machine when fully loaded are also of the same order.

When a needle is broken or a piece of piano-wire is strained to the point of breaking, the maximum tension on the metal will be at the rate of 150 tons per square inch. On the other hand, the pressures that occur in the chambers of large guns do not usually exceed 20 tons per square inch, and the tensile stress on the plates of a ship in heavy weather should not exceed 8 tons per square inch. From these simple instances some idea is gathered of the limitations imposed by materials and dimensions upon apparatus for experimenting at high pressures because of the practical difficulty of hardening and tempering steel in large masses.

When dealing with small amounts of material in each experiment the dimensions allow of the container and the ram being made of tungsten steel, which can be hardened and tempered throughout, and not only superficially, as in the case of ordinary carbon steel.

The material is hard and strong, but not brittle, and it retains these qualities up to moderate temperatures, such as 600° C., to a much greater extent than any other steel.

In one form of container or die the bore is 1⅛ in. in diameter, and it may be used for a limited number of times for a pressure of 200 tons per square inch. It will, however, eventually crack if this pressure is many times repeated, the cracks usually beginning near the bottom of the die.

For still higher pressures it is better to use a double re-entrant container with two rams ½ in. in diameter. Both the container and the rams are made of hardened and tempered tungsten steel, and are rendered fluid and gastight by mild steel cups on the ends of the rams.

If the charge occupies only a short length of the bore, as shown, the barrel of the container where the charge lies is supported by the shear strength of the metal above and below the zone of pressure in addition to its own strength as a tube. Under these conditions it is as strong as or stronger than the crushing strength of the rams, and pressures of 300 tons per square inch may be repeated several times without cracking.

In a container of this form seven grains of fulminate of mercury have been placed, embedded in graphite, and the pressure increased very gradually until it reached 230 tons per square inch (under this treatment fulminate does not usually detonate). The die was then heated by gas to more than 180° C., the temperature of detonation. After two failures of the experiment, owing to the leakage of the steel cups, the third was successful, and no gas escaped and the container was uninjured. The graphite was somewhat caked, but otherwise unaltered. Graphite mixed with sodium nitrate and fulminate was also exploded under the same conditions. Graphite with 15 per cent. of potassium chlorate detonated when 200 tons per square inch had been reached.

Many other reactions were tested in a similar manner in larger dies under pressures of from 40 to 200 tons. The action of concentrated sulphuric acid on sugar was accelerated by a pressure of 50 tons, but, on the whole, these experiments in dies failed to produce any interesting results.

Unfortunately, the heating of the die with its charge cannot be carried much above 500° C. without serious weakening of the steel and compelling a reduction of pressure. The electrical heating of the charge in such small dies, while keeping the die cool, presents great difficulties in electrical insulation on so small a scale to withstand intense pressure, but I think that it might be accomplished in certain instances.

It has been suggested, with the object of reaching higher pressures, that a small die might be bodily immersed in a large container. Doubtless it could be arranged, but it would be very cumbersome to work with, and would only add about 100 tons per square inch to the maximum pressure.

A better plan would be to follow the principle of the usual capped armour-piercing projectile, and to reinforce the rams and ends of the container by tightly fitting copper or bronze rings around the necks of the rams, keeping the parallel part of the noses as short as possible.

When in operation the copper rings will be flattened and squeezed against the necks and shoulders of the rams, and also against the ends of the container, and by this means the parts that ordinarily would have to bear the maximum stress will have part of this stress transferred to other parts not so heavily stressed, and, consequently, the maximum pressure in the container can by this means be raised considerably, perhaps to 450 tons per square inch.

In carrying out experiments on larger samples of material and in applying electrical heating to the charge, the container becomes too large to permit of its being made of hardened steel; therefore, nickel-

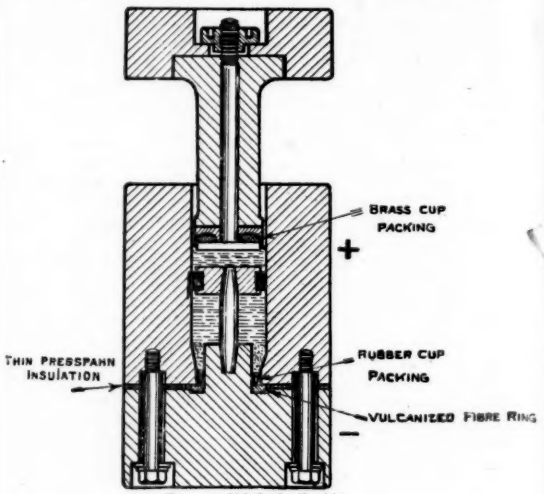


FIG. 1.—Chiefly for liquids.

steel is used, as for the barrels of guns. It is heat-treated by quenching in oil from a high temperature after rough machining. Containers (Figs. 1 and 2) with the thickness of wall equal to the diameter of the bore will stand an internal pressure of 40 tons per square inch repeated almost indefinitely without serious enlargement of the bore, but 100 tons neces-

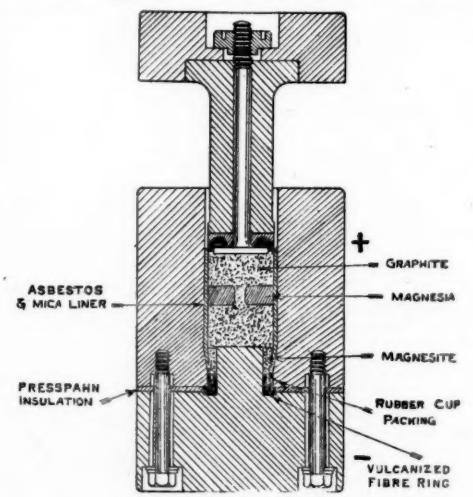


FIG 2.—For melting carbon.

sitates reboring and the fitting of new packing to the ram after each experiment.

Fig. 1 shows the arrangement for electrically heating conductors immersed in fluids under high pressure. The packing of the ram is a cup leather-backed by a cup of brass; the leather first takes the pressure, and the lip of the brass cup is thereby

expanded tightly against the bore of the container, and remains fluid-tight even though the leather should be carbonised by the heat. The bottom pole is electrically insulated from the container by vulcanised fibre washers and a rubber cup-ring, which is protected from the heat by magnesite stemming.

The current is conveyed from the container to the top pole-piece of the conductor by pads of copper gauze, which can slide easily against the bore of the container and allow for the expansion of the conductor. Experiments on liquids with this container under 4400 atmospheres gave the same results as my former experiments under 2200 atmospheres.

Fig. 2 shows the container arranged to melt graphite under pressure by resistance heating. Here the charge is graphite, and is divided by the bridge or ring made of pressed calcined magnesia or of titanium oxide. The bore of the container is electrically insulated from the graphite by layers of asbestos, millboard, and mica.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Notice has been given that there will be an examination for the recently instituted diploma in psychological medicine: Part i. next October, part ii. next December.

OXFORD.—On Tuesday, February 17, the preamble of a statute providing that women may be matriculated and admitted to degrees in the University passed Congregation without a division.

The report recently issued of the Committee for Rural Economy shows a large increase in the number of students. The Michaelmas term began with 200 students, of whom 123 were working at agriculture and 77 at forestry. Lectures have been given on various subjects connected with agriculture, including courses on forest and agricultural botany, live-stock, principles of cultivation, soils and manures, together with the history of agriculture and agricultural economics. Practical laboratory work has been provided, and classes have been held at the University farm.

A vote will be taken in Convocation on the question of Greek in Responsions on Tuesday, March 2. No further amendment being now possible, the statute will have to be passed or rejected as it now stands. Many will regret that the chance of an agreed statute was lost by the opposition of those who objected to the retention of the Greek language as a preliminary requirement even for the final literary and classical examinations. The defenders of Greek were willing to grant exemption to all students of natural science or mathematics, as well as to all passmen, but this concession failed to satisfy their opponents.

A COURSE of three free public lectures on Fermat's last theorem will be given by Mr. L. J. Mordell at the Birkbeck College on March 10, 17, and 24 at 5 o'clock. Tickets of admission are obtainable from the secretary of the college.

THE annual meeting of the Association of Technical Institutions will be held on Friday and Saturday, February 27 and 28, at the Cordwainers' Hall, London, E.C. The proceedings will commence at 10.30 on the Friday morning, when the president-elect, the Marquess of Crewe, will deliver his presidential address. Resolutions will be submitted dealing with pensions and salaries for teachers in technical institutions, and papers will be read by Mr. A. Mansbridge on Technical Schools and their Part in relation to Adult Education, Dr. R. S. Clay on Scholarships, and Mr. H. J. Taylor on Day Continuation Schools.

THE following scholarships will be offered for competition by the Institution of Naval Architects this year:—*Naval Architecture:* Vickers (150*l.* per annum), Hawthorn Leslie (150*l.* per annum), John Samuel White (100*l.* per annum), and Denny (75*l.* per annum). *Marine Engineering:* R. L. Scott (150*l.* per annum) and Denny (75*l.* per annum). These scholarships are open to British apprentices or students, and are tenable (subject to the regulations governing each scholarship) for three years at one or all of the following educational establishments:—Glasgow University, Durham University (Armstrong College), Liverpool University, Royal Naval College (Greenwich), and City and Guilds (Engineering) College (London). Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5 Adelphi Terrace, London, W.C.2.

AN inaugural lecture on "The Universities and the Training of Teachers," delivered at Oxford last October by Mr. F. J. R. Hendy, the Director of Training in the University, has been published by the Clarendon Press in pamphlet form. Mr. Hendy deals briefly with the conditions of the new Education Act and the qualities which will be required for those who are to carry out its provisions for senior elementary, secondary, and continuation schools. In particular, he dwells on the necessity for teachers of a wider and less specialised knowledge, men and women who can take all but the highest work in two, or even three, kindred subjects. The valuable influence of the form-master is something which has tended to disappear from secondary education in recent years, and it should be one of the duties of the training colleges to restore it, at the same time avoiding the danger of superficiality by dividing the subjects of study vertically rather than horizontally, so that, instead of going half-way in two or three honours subjects, a student should go the whole way in a section of each. Some suggestive remarks are made on the subjects of method and psychology, words frequently used, but often misused; also on the immense growth of the administrative side of educational work and the comparatively small expansion of the professional or teaching side. The University Press has done a good service in putting this lecture within the reach of all concerned with the supply of men and women for the teaching profession.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, February 4.—Mr. G. W. Lamplugh, president, in the chair.—J. A. **Douglas**: Geological sections through the Andes of Peru and Bolivia: ii., from the Port of Mollendo to the Inambari River. The paper gives a description of a geological section across the Andes of southern Peru, from the port of Mollendo to the Inambari River, a tributary of the Madre de Dios. The deflection of the Pacific coast-line of South America north of Arica towards the north-west brings to light a zone of ancient granite and gneiss comparable with the rocks of the coastal Cordillera of Chile. These rocks are shown to be of "alkaline" type, and are contrasted with the "calcic" granodiorites forming the batholitic core of the western Cordillera. It is suggested that their formation preceded the uplift of the folded chains. The Jurassic zone of northern Chile has been almost entirely stripped from the underlying plutonic core, but its continuation has been proved at more

than one locality, and in the inter-Andean region strongly folded fossiliferous beds of Bajocian age are found beneath an unconformable Cretaceous series. The batholitic core is shown to comprise at least three distinct phases of plutonic intrusion, represented by granodiorites, diorites, and adamellites. The volcanic cones of the western Cordillera have given rise to an extensive series of lavas and tuffs comparable with the Mauri River series of Bolivia. Cretaceous limestones here take the place of the red gypsiferous sandstones farther south, and are transgressive on to Devonian rocks. The latter contain abundant fossils of Lower Hamilton age. The post-Cretaceous line of dioritic intrusion, formerly described as running through Coro Coro and Comanche, once more appears on the line of section. The Permo-Carboniferous fauna of Bolivia has not been discovered in the district here described.

Optical Society, February 12.—F. G. **Smith**: A ray plotter. Describes a novel instrument for the tracing of a ray through a refracting surface.—J. W. **French**: The surface layer of an optical polishing tool. Suggests a glass layer on the polishing tool as an effective cause of polishing.—Mrs. C. H. **Griffiths**: Diffraction patterns in the presence of spherical aberrations. Photographs in the various planes of the diffraction pattern for an artificial star were taken and measured, with spherical aberration of varying amounts present. These photographs were examined afterwards with the view of determining the relative intensities of light in the different zones of the ring interference and diffraction patterns both at the focus and otherwise.

DUBLIN.

Royal Irish Academy, January 12.—The Most Rev. and Right Hon. J. H. Bernard, president, in the chair.—J. A. **McClelland** and A. **Gilmour**: Further observations of the electric charge on rain. Different sections of the paper deal with the charge on non-thunderstorm rain, thunderstorm rain, snow, and hail. There is also a section dealing with the size of raindrops. The results agree with earlier observations as regards the great excess of positive charge on non-thunderstorm rain. In the case of thunderstorm rain, while the charge per cubic centimetre is greater, the excess of positive over negative is not marked. Raindrops are seldom greater in volume than 5×10^{-3} c.c.; they are usually less than 1×10^{-3} c.c. Raindrops less than a certain size ($0{\cdot}08\times10^{-3}$ c.c.) are, as previously found, always negatively charged. As a rule, drops of this size give little rainfall, but on a few occasions precipitation of this type was quite considerable.—W. B. **Wright**: Minor periodicity in glacial retreat. The terminal moraines of the Killarney and Kenmare district show a marked periodicity in their arrangement, occurring at fairly regular intervals of half a mile to a mile from one another. These moraines are themselves composite, and break up locally into smaller moraines. The smaller moraines are presumed to mark annual retreat stages, as in the neighbourhood of Stockholm—a presumption which gains support from the occurrence of an esker with seasonal mounds between two of the major stages at Kenmare. On this basis the major stages mark a 20- to 40-year periodicity, which is comparable with the climatic periodicity established by Brückner. A much longer periodicity of 500 or 600 years, in which an epoch of linear terminal moraine formation alternates with an epoch characterised by the absence of such moraine formation, is vaguely indicated by the evidence, but not proved.

January 26.—The Most Rev. and Right. Hon. J. H. Bernard, president, in the chair.—Prof. A. **Henry** and Miss M. G. **Flood**: The Douglas firs: a botanical and sylvicultural description of the various species of Pseudotsuga. Six species and one variety were investigated. The microscopical structure of the leaves was found to be distinct and constant in each species, being correlated with the special climate in which the tree lives. The Colorado and the Oregon Douglas firs exemplify this well, the leaf-anatomy of the former showing xerophytic features, which are adaptations to the dry continental climate of the Rocky Mountains. These two distinct species (*P. glauca* and *P. Douglasii*), usually regarded as of only varietal rank, are treated very fully. The remarkable difference in the odour exhaled by these two trees led to a chemical examination of the oils distilled from their foliage by Mr. C. T. Bennett. The delicious fragrance of the Oregon species was found to be due to the presence in the leaf-oil of geraniol, pinene being absent. The strong turpentine odour of the Colorado species is associated with the presence in its leaf-oil of large percentages of pinene and bornyl acetate.

Royal Dublin Society, January 27.—Dr. F. Hackett in the chair.—Prof. J. **Wilson**: The application of the food-unit method to the fattening of cattle. Thirty years ago N. J. Fjord commenced by experiments to determine what quantities of several other feeding-stuffs were equivalent to 1 lb. of barley, and his successors in Denmark and Sweden have so developed his method that there is now scarcely a feeding-stuff the feeding value of which they cannot express in terms of barley, which they have retained as the unit. Many fattening experiments have been carried out in Britain during the last eighty or ninety years, but, having no very general purpose, they have led to no very definite result. By applying Fjord's method to these experiments, however, the relative efficiencies of the various rations can be approximately determined and suggestions made for improvement in the use of feeding-stuffs for stock of all kinds.—Prof. H. H. **Dixon** and H. H. **Poole**: Photo-synthesis and the electronic theory. The modern view of the part played by sensitisers of the photographic film suggests the hypothesis that green-leaf pigment, which acts as a sensitiser to the wave-lengths it absorbs, loses electrons under the action of the absorbed light. This would suggest a photo-electric theory for photo-synthesis. Accordingly, the photo-electric properties of leaf pigment were tested qualitatively at first by several methods. These giving no indication of photo-electric activity under the action of light active in photo-synthesis, a more refined quantitative method was employed. This showed that the number of electrons ejected, even under intense illumination, from a film of leaf pigment or from a layer of leaf-powder is negligible in the photo-synthetic process. The result supports the view that the displacement of electrons, which we should expect to be the first step in photo-synthesis, must be entirely confined within the pigment-complex of the leaf, or even within the molecules of one of the pigments, and lends no support to the hypothesis that the pigment, by emitting electrons under the action of light, is able to build up carbohydrates external to itself.

PARIS.

Academy of Sciences, January 19.—M. Henri Deslandres in the chair.—M. **Hadamard**: The elementary solution of linear hyperbolic non-analytic partial differential equations.—H. **Douvillé**: The limit between the Cretaceous and the Eocene in Aquitaine, India, and the Sudan.—C. **Deperet**: An attempt at a general chronological co-ordination of Quaternary time.—P. **Boutroux**: A family of multiform functions

associated with a differential equation of the first order.—G. **Valiron**: The theorem of M. Picard and the generalisations of M. Borel.—M. **d'Ocagne**: The distribution of curvatures round a point on a surface.—J. **Villey**: Explosion motors for rarefied atmospheres. Five methods are classified by means of which a normal motor may be made more effective at high altitudes.—G. **Claude**: The advantages of the synthesis of ammonia at very high pressures. At 1000 atmospheres the number of passages of the gaseous mixture over the catalyst necessary for complete combination can be reduced to three, and, as a consequence, the volume of the part of the apparatus containing the catalyst can be reduced to at least one-tenth of that currently in use in German practice. At this pressure the ammonia formed can be liquefied out by simply cooling with water.—W. A. **Noyes**, jun.: Polarisation in iron solutions. The Nernst formula does not apply to the polarisation of iron solutions, but indicates values proportional to the experimental values.—C. **Matignon** and E. **Monnet**: The reversible oxidation of sodium nitrite. Sodium nitrite heated to about 500° C. with oxygen under pressure (175 atmospheres) is almost completely oxidised to the nitrate. The reaction is slow, but possibly a suitable catalyst may make the reaction of practical interest in the synthetic nitrate and nitrite industry.—G. **Chaudron**: The reversible reaction between steam and molybdenum.—F. **Kerforne**: Some observations on the Redonian sea of Brittany.—J. **Couégnas**: Contribution to the study of the Argentat fault between Eymoutiers and Treignac.—H. **Coupin**: The causes of the elongation of the stem of etiolated plants. Plants grown in the dark in water containing the juice extracted from green plants do not have elongated stems, but resemble seedlings grown in the light.—E. **Gain** and A. **Gain**: The thermal differences of opposite sides of a lacustral valley.—A. **Guilliermond**: The evolution of the chondriome in the plant-cell.—R. **Mirande**: Alum carmine and its use, combined with iodine green in plant histology. Alum carmine should be considered as a stain for pectic materials, and not for cellulose, as usually believed.—G. **Mangenot**: The evolution of the chondriome and plasts in Fucus.—G. **Arnaud**: The family of the Parodiellinaceæ.—A. **Marie** and L. **MacAuliffe**: The anthropometric study of 136 natives of Tunis.—J. **Pellegrin**: The sub-fossil fish strata of the Tchad low country and their signification.—J. **Legendre**: The food of the Madagascan perch.

January 26.—M. Henri Deslandres in the chair.—Y. **Delage**: An integrating Pitot tube for measuring the average velocity of variable currents. The instrument, a diagram of which is given, is based on the measurement of the water flowing from the upper end of the Pitot tube at the sea-level.—F. **Widal** and P. **Vallery-Radot**: Anaphylaxy due to antipyrin after a long phase of sensibilisation. The case described had taken antipyrin monthly for nine years before any trouble arose, then each dose of antipyrin produced definite effects, localised in the lips. After seven years without this drug, antipyrin immediately reproduced the same symptoms. The treatment by which this anaphylactic state was cured, following the method of Pagniez, is described.—J. **Andrade**: The photographic measurement of rolling resistance.—L. and E. **Bloch**: A spectroscopic arrangement for the study of the extreme ultra-violet. The prism and lenses are made of fluorspar, and air absorption is prevented by maintaining the whole apparatus in a high vacuum (0·001 mm.) by means of a Gaede pump. Spark spectra of several metals have been photographed with apparatus down to a wave-length of 1550 Ångström units.—E. **Wourtzel**: The velocity of oxidation of nitric oxide. The oxidation of nitric oxide by oxygen is a reaction of the third order, and the course of the reaction undergoes no sudden modification when half the nitric oxide is oxidised. The velocity of the reaction diminishes as the temperature rises.—C. **Matignon** and Mlle. G. **Marchal**: Some properties of sodium nitrite. Determinations of the melting point (276·9° C.), heat of solution, heat of neutralisation, heat of formation, and action on colouring matters. An aqueous solution of sodium nitrite at 100° C. in oxygen at 50 to 55 atmospheres remained unoxidised during five or six hours. Platinum black is without action as a catalyst.—A. **Kling**, D. **Florentin**, and E. **Jacob**: The properties of the chlorinated methyl carbonates. All nine possible chlorine substitution products of methyl carbonate have been prepared, and their physical properties are given in a table.—G. **du Bellay** and M. **Houdard**: The chemical properties of humus and their utilisation for the protection of combatants against asphyxiating gases. Filtration of air through about 60 cm. of earth containing humus can protect against chlorine and phosgene for several hours.—P. **da Souza**: Contribution to the lithological study of the interior of Angola.—F. **La Porte**: The beaches of Gâvre and Penthièvre (Morbihan).—E. **Mesnard**: Lunations and rainy periods.—Ch. **Dufour**: Values of the magnetic elements at the Val-Joyeux Observatory on January 1, 1920.—E. **Surgis**: Contribution to the study of the Frankeniaceæ.—A. **Vandel**: The development of the copulating apparatus in the Planaria is under the control of the genital glands.—L. **Léger**: Young fresh-water stages and biology of the marine lamprey.

BOOKS RECEIVED.

Peat Industry Reference Book. By F. T. Gissing. Pp. xxiv+292. (London: C. Griffin and Co., Ltd.) 7*s*. 6*d*.

Airman's International Dictionary, including the most Important Technical Terms of Aircraft Construction. English, French, Italian, German. By M. M. Dander. Pp. vii+227. (London: C. Griffin and Co., Ltd.) 6*s*.

Contributions to the Genetics of *Drosophila melanogaster*. By T. H. Morgan and others. Pp. v+388+12 plates. (Washington: Carnegie Institution of Washington.)

A New Type of Hereditary Brachyphalangy in Man. By O. L. Mohr and C. Wriedt. Pp. 64+7 plates. (Washington: Carnegie Institution of Washington.)

Displacement Interferometry by the Aid of the Achromatic Fringes. By Prof. C. Barus. Part iv. Pp. 122. (Washington: Carnegie Institution of Washington.)

Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Pp. iv+128+4 plates. (Washington: Carnegie Institution of Washington.)

Contributions to the Geology and Paleontology of the West Indies. Pp. 184+plates. (Washington: Carnegie Institution of Washington.)

Climatic Cycles and Tree-Growth. By A. E. Douglass. Pp. 127+12 plates. (Washington: Carnegie Institution of Washington.)

The Environment of Vertebrate Life in the Late Paleozoic in North America. By Prof. E. C. Case. Pp. vi+273. (Washington: Carnegie Institution of Washington.)

A Biochemic Basis for the Study of Problems of Taxonomy, Heredity, Evolution, etc. By Prof. E. T. Reichert. Part i. Pp. xi+376+34 plates. Part ii. Pp. vii+377–834. (Washington: Carnegie Institution of Washington.)

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. H. Smith: Illustrations of Ancient Greek and Roman Life in the British Museum.

ROYAL SOCIETY, at 4.30.—Prof. B. Moore and T. A. Webster: Studies of Photo-synthe-is in Fresh-water Algæ.—Prof. W. M. Bayliss: The Properties of Colloidal Systems. IV. Reversible Gelation in Living Protoplasm.—Rev. F. J. Wyeth: The Development of the Auditory Apparatus in *Sphenodon punctatus*.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. S. R. Gloyne: The Problem of Immunity in Tuberculosis.

LINNEAN SOCIETY, at 5.—J. S. Huxley and D. F. Leney: Specimens of Sexually Mature Axolotls Metamorphosed into the Amblystoma Form by Feeding with Thyroid Gland, and of Urodele Larvæ Precociously Metamorphosed by Treatment with Iodine Solution.—Major H. C. Gunton: Entomologico-Meteorological Records of Ecological Facts in Life of British Lepidoptera.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—T. B. Stevens and C. E. Blackett: The Use of Haloid Cyanides for the Purpose of Gold Extraction.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Commr. B. T. Coote: Physical Education and its relation to National Ideals.

CHEMICAL SOCIETY, at 8.—S. B. Schryver and C. C. Wood: A New Method for the Estimation of Methyl Alcohol.—C. S. Gibson and Sir William J. Pope: ββ'-Dichloroethyl Sulphide.—B. Flurscheim: The Relation between the Dissociation Constants of Acids and Bases and the Quantitative Distribution of Affinity in the Molecule.—S. Dhar: Direct Replacement of Negative Groups by Halogen in the Achromatic Series. Part I. Replacement of Nitro-group by Bromine.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, FEBRUARY 20.

GEOLOGICAL SOCIETY OF LONDON, at 3.—(Anniversary Meeting.)

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. G. Elliot Smith: The Evolution of the Cerebellum (Arris and Gale Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Annual General Meeting), at 6.—E. M. Bergstrom: Recent Advances in the Utilisation of Water Power (Resumed Discussion).

CONCRETE INSTITUTE (at 296 Vauxhall Bridge Road), at 6.—H. K. Dyson: Some Points in Reinforced Concrete Design.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at Faraday House), at 7.—A. Serner and Others: Discussion on State Ownership *v.* Private Enterprise.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—Prof. F. W. Burstall: Obscure Points in the Theory of the Internal-combustion Engine.

SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.30.—Col. W. G. King and Others: Discussion on Small-Pox.—Lt.-Col. N. H. Fairley and Capt H. R. Dew: Causes of Death from Malaria in Palestine: A Study in Cellular Pathology.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. E. J. Russell: British Crop Production.

SATURDAY, FEBRUARY 21.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

PHYSIOLOGICAL SOCIETY (at Lister Institute), at 4.

MONDAY, FEBRUARY 23.

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. G. Elliot Smith: The Evolution of the Cerebellum (Arris and Gale Lecture).

ROYAL SOCIETY OF ARTS, at 8.—C. F. Cross: Recent Researches in the Cellulose Industry (Cantor Lecture).

MEDICAL SOCIETY OF LONDON, at 8.30.—Sir Charters Symonds: The Surgical Treatment of the Later Stages of Gunshot Injuries of the Chest and of Empyema.—Dr. P. M. Smith: The After-results of Certain Surgical Operations.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Jay Hambidge: Greek Design.

TUESDAY, FEBRUARY 24.

ROYAL HORTICULTURAL SOCIETY, at 3.—J. Hudson: The Cultivation of Fruits under Glass with a Minimum of Fire Heat.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. Wilson: Magnetic Susceptibility.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Sir F. J. E. Spring: Restoration of a Cyclone-Damaged Breakwater End in Madras Harbour, and Coastal Sand Travel near Madras Harbour.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the month of January, 1920.—E. G. Boulenger: On some Lizards of the Genus Chalcides.—N. S. Lucas: Report on the Deaths in the Gardens in 1919: with Notes on Rickets and Avian Enteritis.—S. Hirst: Revision of the English Species of Red Spider (Genera Tetranychus and Oligonychus).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Lantern Meeting), at 7.—Dr. C. A. Swan: Wanderings in Italy.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Dr. T. L. Llewellyn and Others: Discussion on Lighting Conditions in Mines, with special reference to the Eyesight of Miners.

WEDNESDAY, FEBRUARY 25.

ROYAL SOCIETY OF ARTS, at 4.30.—J. Currie: Industrial Training.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—H. C. Sargent: The Lower Carboniferous Chert Formations of Derbyshire.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at Examination Rooms of the Royal College of Physicians, 8-11 Queen's Square, W.C.), at 6.—Dr. H. M. Vernon: The Effect of Change in Hours of Work on Output.

THURSDAY, FEBRUARY 26.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—A. H. Smith: Illustrations of Ancient Greek and Roman Life in the British Museum.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, RÖNTGEN SOCIETY, and ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (at Royal Society of Medicine), at 5 and 8.15 (Joint Discussion on Electrical Apparatus in relation to X-rays).—Dr. R. Morton: The Efficiency of High-Tension Transformers as used for X-ray Purposes.—Major C. E. S. Phillips: The Problems of Interrupted and Fluctuating Currents.—R. S. Wright: High-Tension Transformers.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. Castellani: The Higher Fungi in relation to Human Pathology (Milroy Lecture).

CONCRETE INSTITUTE (at Vauxhall Bridge Road), at 7.30.—E. F. W. Grimshaw: Reinforced Concrete Fences and Posts.

FRIDAY, FEBRUARY 27.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section), at 4.30.—Dr. Mellanby and Others: Discussion on The Influence of Accessory Food Factors in Infant Feeding.

PHYSICAL SOCIETY, at 5.—T. Smith: The Balancing of Errors.—Dr. N. W. McLachlan: The Testing of Bars of Magnet Steel.—G. D. West: The Forces Acting on Heated Metal Foil Surfaces in Rarefied Gases.—Miss N. Hosali: Exhibit of Crystal Models.

WIRELESS SOCIETY OF LONDON (at Royal Society of Arts), at 8.—A. A. Campbell Swinton: Some Wireless Wonders (Presidential Address).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—W. B. Hardy: Problems of Lubrication.

SATURDAY, FEBRUARY 28.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

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